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JOHNS HOPKINS UNIVERSITY CIRCULARS

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CALENDAR, 1883–84.

Tuesday, September 18.	**Current Academic Year Began.**
Tuesday, September 25.	**Instructions Resumed.**
Thursday, November 29.	**Thanksgiving Day.**
Wednesday, December 5.	**Meeting of Scientific Association, 8 p. m.**
Friday, December 7.	**Meeting of Philological Association, 12 m.**
Tuesday, December 11.	**Mr. J. T. Clarke's Course in Archæology Begins. (See p. 16).**
Tuesday, December 11.	**Meeting of Metaphysical Club, 8 p. m.**
Wednesday, December 19.	**Meeting of Mathematical Association, 8 p. m.**
Saturday, Dec. 22.—Wednesday, Jan. 2.	**Christmas Recess.**
Friday, June 7.	**Term of Instruction Closes.**

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The Circulars, Annual Report, and Register of the University will be sent by mail for $1.00 yearly. Subscriptions may be addressed to the Publication Agency, Johns Hopkins University, Baltimore. Price of Circular, 1882-83, bound in cloth, $2.00.

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SCIENTIFIC NOTES

On the work of Members of this University in Mathematics, Physics, Chemistry, Biology, Ancient and Modern Languages, History, Political Science, Psychology, Ethics, and Logic.

COMMUNICATIONS TO THE HISTORICAL AND POLITICAL SCIENCE ASSOCIATION.

The Seminary Method, by H. B. ADAMS.

[Abstract of a paper read at a meeting of the University Historical and Political Science Association, September 28, 1883].

The Seminary, like the College and University, is of ecclesiastical origin. Historically speaking, the *Seminarium*, or, as the German students call it, the *Seminar*, was a nursery of theology and a training-school for Seminary priests. The modern theological seminary has evolved from the mediæval institution, and modern seminary students, whether at school or at the University, are only modifications of earlier types. The Church herself early began the process of differentiating the ecclesiastical seminary for secular purposes. Preachers became teachers, and the propaganda of religion prepared the way for the propaganda of science. The Seminary method of modern Universities is, therefore, merely the development of an old institution into new uses, among which is the professional training of historical students, and the discovery of new truth in the training process.

At the University of Heidelberg, as elsewhere in Germany, there are Seminaries for advanced training in various departments of learning, chiefly, however, in Philology and in other historical sciences. The Philological Seminary, where the use of the Latin language for formal discussion is still maintained at some Universities, is, perhaps, the connecting link between mediæval and modern methods of scholastic training. In the Greek Seminary of the late Professor Koechly, at Heidelberg, the training was prëeminently pedagogical. The members of the Seminary took turns in occupying the Professor's chair for one Philological meeting, and in expounding a classical author by translation and comment. After one man had thus made trial of his abilities as an instructor, all the other members took turns in criticising his performance, the Professor judging the critics and saying what had been left unsaid.

In the Historical Seminary of Professor Erdmannsdoerffer the method was somewhat different. It was less formal and less pedagogical. Instead of meeting as a class in one of the University lecture-rooms, the Historical Seminary, composed of only six men, met once a week in a familiar way at the Professor's own house in his private study. The evening's exercise of two hours consisted in the critical exposition of the Latin text of a mediæval historian, the *Gesta Frederici Imperatoris*, by Otto, Bishop of Freising, who is the chief original authority upon the life and times of Frederick Barbarossa. As in the Greek Seminary, so here, members took turns in conducting the exercises, which, however, had less regard for pedagogical method than for historical substance. Each man had before him a copy of the octavo edition of Bishop Otto's text, and the conductor of the Seminary translated it into German, with a running comment upon the subject matter, which he criticised or explained in the light of parallel citations from other authors belonging to Bishop Otto's time, who are to be found in the folio edition of Pertz's *Monumenta Germaniae Historica*. From this method of conducting the Seminary, it would appear as though one man had all the work to do for a single evening, and then could idly listen to the others until his own turn came once more. But it was not so. Subjects of discussion and for special inquiry arose at every meeting, and the Professor often assigned such subjects to the individual most interested for investigation and report.

An illustration of Seminary-work relating more especially to Modern History and Politics, was given from similar experience in the private class of the late Dr. J. C. Bluntschli, Professor of Constitutional and International Law at Heidelberg. In his Seminary, the exercises were in what might be called the Comparative Constitutional History of Modern European States, with special reference to the rise of Prussia and of the New German Empire. He himself always conducted the meetings of the Seminary. Introductory to its special work, he gave a short course of lectures upon the History of Absolute Government in Prussia and upon the influence of French and English Constitutional Reforms upon Belgium and Germany. He then caused the Seminary to compare in detail the Belgian Constitution of 1880 with the Prussian Constitution of 1850. Each member of the Seminary had before him the printed texts, which were read and compared, while Bluntschli commented upon points of Constitutional Law that were suggested by the texts or proposed by the class. After some weeks' discussion of the general principles of Constitutional Government, the Seminary, under Bluntschli's skilful guidance, entered upon a special and individual study of the relations of Church and State, in the various countries of Europe, but with particular reference to Belgium and Prussia, which at that time were much disturbed by conflicts between the civil and the ecclesiastical power. Individual members of the Seminary reported the results of their investigations and interesting discussions always followed. The result of this Seminary-work was an elaborate monograph by Bluntschli himself upon the Legal Responsibility of the Pope, a tractate which the Ultramontane party thought inspired by Bismarck, but which really emanated from co-operative studies by master and pupils in the Heidelberg Seminary.

Some account of methods of work in the department of History at Harvard College, in the University of Michigan, in the University of Wisconsin, and at the Johns Hopkins University, will be published in the January number of the "University Studies in Historical and Political Science," as an introduction to the Second Series. This paper, entitled "New Methods of Study in History"—the Special or Topical Method, the Comparative, the Co-operative, and the Seminary Methods—was read before the American Social Science Association at Saratoga, September 4, 1883.

The Records of the Virginia Company and Notes on Early Maryland History, by EDWARD D. NEILL, President of Macalester College, Minnesota.

[Abstract of a communication to the University Historical and Political Science Association, October 5, 1883].

Rev. Dr. Neill, author of "*Terra Mariae*," "The Founders of Maryland," "English Colonization of America," and of a "History of the Virginia Company," called the attention of the seminary to two folio volumes now in the Congressional Library, which contain material upon the basis of which the early history of Maryland, Virginia, and perhaps other colonies is yet to be reconstructed. They contain the transactions of the Virginia Company from 1619 to 1624, and have had an eventful history. During the period of the Spanish marriage-complications in England, Gondomar, the Spanish ambassador, intrigued to have these records destroyed. Before his object could be accomplished, however, Nicholas Ferrar, one of the adventurers, had copies of them taken, which were deposited with the Earl of Southampton. They then came into the possession of the father of Col. William Byrd, of Westover. The Byrd library was subsequently bought by Rev. Wm. Stith, president of William and Mary College, who made them the basis of his "History of Virginia." After his death they passed into the possession of his brother-in-law, Peyton Randolph, whose library was afterwards purchased by Thomas Jefferson, and they finally came into the possession of the United States with the Jefferson papers which were purchased by our government. These two folio volumes are said to contain material hitherto unused and of fundamental importance to our early colonial history. The seminary will endeavor to make use of these origi-

nal records. Dr. Neill suggested that influence be brought to bear upon Congress for their publication.

President Neill is preparing a notice of Thomas Cornwallis, councillor, and the guiding mind of the first Maryland colony, for publication in the magazine of the Pennsylvania Historical Society. This paper will show the difference between the charter of Avalon granted to the first Lord Baltimore and the charter of Maryland. The Avalon charter grants to Sir George Calvert, knight, "the patronages and advowsons of all churches which, as Christian religion shall increase, shall happen hereafter to be erected." The Maryland charter adds to this the restrictive clause that all churches, chapels and places of worship shall be "dedicated and consecrated according to the ecclesiastical laws of our kingdom of England."

The paper will show that Cecil, Lord Baltimore, staked but little money in the first colony. His own words, in a letter to the Earl of Strafford, are that he had "sent a hopeful colony into Maryland, with a fair and probable expectation of good success, however, without any danger of any great prejudice unto myself, in respect that others are joined with me in the adventure." Father White, the zealous Jesuit missionary among the first colonists, wrote to his superior that three out of four of the first settlers were Protestants. Some writers have said the workingmen were only referred to, but that the gentlemen were adherents of the Church of Rome. It will be shown that Thomas Cornwallis and all of the leading minds of the first colony were opponents of the Church of Rome. It will be shown that the royalist Governor of Maryland fined Cornwallis for assisting Richard Ingle, who came in a Parliament ship and took Father White prisoner; also that Cornwallis in other ways showed his affection for Parliament.

Icaria—A Fragment of Communistic History, by ALBERT SHAW.

[Abstract of a paper read before the Historical and Political Science Association October 19, 1883.]

This paper consisted of a sketch of the career of the French communist, Étienne Cabet, with a detailed account of his communistic doctrines and his attempt at their realization by means of an experimental colony in America. The history of this so-called "Icarian Community" was brought down to the death of Cabet, in 1856, its subsequent story being reserved for a second paper. The study is based upon original French documents and sources not examined by previous writers, (Nordhoff, Hinds, et al.), and upon careful personal interviews with the few surviving members of the original migration. It is believed that this is the first attempt at an accurate and complete sketch of Icarian history.

Cabet was born in the year 1788, grew up an enthusiastic democrat, studied law, took active part in the July Revolution of 1830, was banished for his radicalism by Louis Philippe in 1834, and spent five years in England, where study and reflection made him a communist, and where he wrote his famous book, "The Voyage in Icaria." He returned to France in 1839, and published his book the next year. Its success was immediate and great, and within six or seven years his followers, known as Icarians or Cabetists, numbered several hundred thousand. "The Voyage in Icaria" is a romance in which is pictured in great detail the happy social life of an imaginary country called Icaria, which has adopted communism. Mechanics and workingmen were the chief adherents of Icarianism. Cabet, in 1841, founded a newspaper, *Le Populaire*, in which he defended his doctrines, and he wrote innumerable tracts and polemics. He decided to demonstrate the feasibility of his theory by a colony in Texas.

February 3, 1848, 69 pioneers left Havre for New Orleans, expecting to be followed by 1,500 in a few weeks. From New Orleans they proceeded to Shreveport, La., expecting to find that the lands they had bargained for were on the Red River. They learned that they must trudge more than 200 miles from Shreveport, and that the lands which they had supposed were purchased for them were only theirs subject to actual occupancy, and were, moreover, not contiguous but were the halves of alternate sections. These disappointments were followed by terrible malarial fevers. Meanwhile, in France the February Revolution of 1848 had changed the aspect of affairs, and the 1,500 men who were to have followed the Icarian pioneers as a "second advance-guard," dwindled to 19, who reached their unhappy brethren of the first guard in time only to join in the abandonment of Texas and the retreat to New Orleans. Unaware of the extent of this Texas disaster, several embarkations followed, including Cabet himself, and early in 1849 there had gathered in New Orleans nearly 500 Icarians. The great Icarian school in Europe had been fatally severed by the events of the Revolution, one party desiring to abandon the colonization scheme and work for the realization of a communistic democracy in France, and the other party adhering to the emigration idea.

The question in New Orleans now was the practical one of a home. Inability to agree caused the withdrawal of nearly half the community, and the remainder, abandoning Texas forever, went up the Mississippi to Nauvoo, Illinois. Nauvoo had been recently vacated by the Mormons, and the Icarians were therefore able to rent houses and land at nominal figures, which, in their depleted financial condition, was most fortunate. The brief compass of this abstract will not permit a description of their social life at Nauvoo, further than the statement that they increased steadily in numbers and wealth, and maintained for six years a harmonious, happy communal life, characterized by industry, morality, and intelligence. Cabet was now nearly 70 years old, and his fondness for power had grown while his executive capacity had declined. His demand for a more arbitrary form of government produced a dissension which severed the community, one-half remaining at Nauvoo, and the other half under the leadership of Cabet, withdrawing to St. Louis. This was in the fall of 1856. Cabet had been in St. Louis scarcely a week when a stroke of apoplexy ended his strange and adventurous career. His followers formed themselves into a community near St. Louis, which they named Cheltenham; and the other wing, after remaining at Nauvoo a few years, removed to Southwestern Iowa. The story of their successes and failures after the death of their founder, and of their present fortune and condition, will furnish material for a concluding paper.

Christian Socialism in England, by R. T. ELY.

[Abstract of a paper read before the Historical and Political Science Association, September 28, 1883].

The Rev. Frederick D. Maurice may be considered the originator of this movement which began in England in 1849. His chief co-workers were young men like Mr. Thomas Hughes, Mr. Vansittart Neale, Mr. Ludlow and Rev. Charles Kingsley, whom he had gathered about him in his pastoral work in London and through his writings. He was a man of extreme diffidence but possessed of a wonderful magnetism which drew men to him and inspired confidence.

The immediate impelling cause of Christian Socialism was the wretched condition of the laboring classes in England as revealed by the disclosures following in the wake of the revolutionary year 1848. Parliamentary commissions conducted protracted investigations and inquiries, which revealed the intolerable wretchedness of the poor. Women performed the labor of beasts of burden, children who ought to have been at play were murdered by over-work, and the struggle for existence bore so heavily on men that they became old at thirty. It was at this time that the condition of the laboring men appeared to many like "a hell without hope and without escape."

Maurice told his young disciples that a continuance of such a state of things was impossible and set them to work among the poor of his own parish. They started a night school, which subsequently developed into the Working Men's College. This was endowed by Maurice with about all the property he ever had and is now doing an excellent work under the presidency of Sir John Lubbock.

About this time Mr. Ludlow went to France and became acquainted with the productive coöperative associations, started by Louis Blanc, which were in a flourishing condition. He returned to England and told his confrères what was going on across the Channel. Coöperation appeared to them a wonderful institution, and they "determined to have some of it in England." Coöperative undertakings were started with great enthusiasm and generous devotion. Mr. Neale, who has ever been a faithful friend of the working man, put his entire fortune into the movement. The business basis was bad. No examination was made of the character of applicants for admission to the undertakings, and money was lent to workers at four per centum with no other security than tools and mate-

rials purchased by loans. Every band of workers failed and Christian socialism came temporarily to a stand-still. Mr. Kingsley became discouraged and fell out of the ranks, but Mr. Neale, Mr. Hughes and others kept bravely on and allied themselves to the distributive coöperation of the north of England, which received a mighty impulse from the Rochdale Pioneers. This association and many others have formed themselves into a Union, a great organization which now embraces directly or indirectly four or five millions of Englishmen. It has thus become leavened by the notions of practical Christianity as taught by Maurice and his followers. The three principles as formulated by Maurice, are the following:

I. That human society is a brotherhood, not a collection of warring atoms;

II. That true workers should be fellow-workers, not rivals;

III. That a principle of justice not of selfishness should regulate exchanges.

It is in the ultimate and complete triumph of coöperation that Mr. Hughes sees the salvation of England.

NOTE.—A considerable part of the material for the paper of which the above is an abstract, was kindly furnished the writer by Mr. Hughes in personal conversation during his recent visit in this country.

NOTES IN BIOLOGY.

Abstract of Observations on the Development of Balanoglossus, by WILLIAM BATESON, Cambridge, England.

[Note from the Chesapeake Zoölogical Laboratory, 1883].

An unlimited quantity of this remarkable form was easily to be obtained at half-tide all along the shores in the neighborhood of Hampton, Virginia. The difficulties attending the investigation were far less than those that have been previously met with at other localities. Since the time during which I have been able to remain in America was exceedingly limited, I thought it best to confine my work at Hampton to the study of fresh specimens of the animal, and to the task of collecting and preserving them for subsequent examinations by means of sections. My observations are, therefore, very meagre and inadequate, especially as regards the organogeny of the form, owing to the extreme scarcity of the larva. These important deficiencies I hope subsequently to supply when I shall have been able to examine my material by sectional methods. The general appearance of the Hampton form presents many points of slight divergence from the species common at Naples (*B. minutus*), so that at first sight the two animals seem very different, but whether the anatomy of this form is essentially different, I could not decide by examination of fresh specimens alone. The principal result of my work has been to show that the form common on the Chesapeake coast does not pass through the Tornaria stage, which has been described by previous observers as the larva of Balanoglossus. The eggs of this animal are opaque, yellowish grey bodies, inclosed in a thin tough egg-shell which is quite transparent. Segmentation is begun by the appearance of a median furrow which divides the egg into two equal halves. This is followed by another median furrow at right angles to the first, forming four segments. In the next stage that I have been able to observe segmentation was complete, having probably proceeded in a regular manner, though of this I have not been able to determine. One edge of this blastospore is next flattened and gradually depressed, causing the embryo to take the shape of a concavo-convex disk. The concavity becomes gradually reduced in size as its edges grow together to form the blastospore, appearing at the same time to become thickened. This process is continued until the blastospore becomes exceedingly small; whether it subsequently disappears or not I cannot say until I have cut sections of it. I believe, however, that it becomes the anus, which at all events is found in the same position. As this gastrula becomes shut off it resumes the spherical shape and begins to rotate about the axis, which eventually becomes the long axis of the animal, at the top of which the blastospore is placed. This rotary movement is caused by a uniform covering of fine cilia. After rotating in this way for some few hours, the body elongates and a ring of large cilia appears surrounding the posterior end. The animal then swims round the egg, rotating at the same time on its long axis. A nearly median transverse constriction next occurs, which is followed by another one anterior to it, giving the body the appearance of being composed of three segments. The anterior segments become the proboscis, the middle one forms the collar, and from the posterior portion the rest of the body is developed. Within the anterior constriction the mouth is subsequently formed. At the anterior end of the proboscis a tuft of fine long cilia grows out as in the larvæ of many Chœbopoda, etc. A pair of depressions are at the same time formed posteriorly to the collar in a dorsal position. These depressions form the first pair of gill slits. In this condition the larva is generally hatched, though I have found individuals already free before the appearance of the transverse constriction. On hatching these larvæ are still quite opaque, and live buried in the muddy sand which the adults inhabit. In this condition the animal remains for some time, increasing in size, until it is about an eighth of an inch long, the proboscis being about half the total length of the body. The tip of the proboscis is used by the larvæ to attach themselves by suction to foreign bodies, though apparently no special suctorial organ exists. As the body grows, the posterior band of cilia becomes wider and the cilia themselves longer and coarser, while the direction of the band alters slightly. From the appearance of fresh specimens in this stage, treated with acetic acid, I believe that several pouches arise from the gut which probably are destined to form the other gill slits, but this is quite uncertain, though of course sections will at once decide this question. I have been unable to procure any specimens older than these, and of the changes by which this larva becomes converted into Balanoglossus, I can therefore say nothing. Possibly the animal remains in this condition during the winter and awaits the spring for its final developments. I hope to be able to observe the subsequent stages at some future season.

On the Osteology and Development of Syngnathus Peckeanus (Storer), by J. PLAYFAIR MCMURRICH, M. A., Guelph, Ontario.

(This paper is an abstract of observations which were made during the past winter upon embryos obtained at Beaufort during the preceding summer).

The embryonic cranium is characterized by its relative shortness as compared with the adult, a character due to the bending up at their extremities of the coalesced Trabeculæ Cranii. As development proceeds this bending up does not diminish, but the mouth is carried forward by a growth of the horizontal portion of the trabeculæ and it is not until a comparatively late stage that the elongation of the snout is dependent upon the straightening out of the rostral cartilage. In the adult the occipital region extends comparatively far forwards while the proötic region is exceedingly compact. Basi-, ali-, and orbito-sphenoids are wanting, so that the canal for the passage of the orbital muscles is exceedingly large. There are no nasals, and the parietals are small and merit the term "dermo-epiotics."

With regard to the suspensorial, hyoid and branchial apparatus, the symplectic is very long, and as a consequence there is a separation of the hyomandibular and metapterygoid elements. The ethmo-palatine cartilage is at first quite separate from the pterygoid process of pterygo-quadrate but finally unites with it. Mr. J. A. Ryder has described these cartilages in Hippocampus as the intermaxillary and maxillary cartilages respectively, a nomenclature, which from our knowledge of the development of these parts, and as I have satisfied myself by tracing the subsequent history of the cartilages, is incorrect. In the adult the great elongation backwards of the metapterygoid and quadrate bones, the abortion of the genio-hyoid which is well marked in embryonic stages and the absence of intermaxillaries are traceable points. The branchial arches are never more than four and are exceedingly simple in structure.

The dermal scales appear as stout membranous plates in which ossification takes place concomitantly with that of the neural and transverse processes of the vertebræ, as a result of which the scales become supported

by or sit astride of the vetebral processes, thus giving firm protection to the structures within and replacing the ribs. During embryonic life an anal fin is present, which however does not develop completely and disappears entirely in the adult.

The gills are in reality not tufted but their appearance is due to the leaflets, of which there are four rows to each rachis, gradually increasing in size from below upwards until near the extremity when they suddenly decrease. The degeneration of the arches and the peculiar arrangement of the leaflets I imagine to be due to the almost complete closing in of the gill-cavity, which is evidently an old ancestral character, since even in the youngest stages the branchial-cavity was completely closed by a membrane. No communication exists between the intestine and the yolk-sack, and a valve is early formed by a constriction of the walls of intestine, which separates the rectum from the intestine proper.

An Instance of Sexual Color Variation in Crustacea, by H. W. CONN.

[Note from the Chesapeake Zoölogical Laboratory, 1883].

Differences in the color of the two sexes among Crustacea are of very rare occurrence. Darwin in *The Descent of Man*, chap. ix, refers to this fact and says he is acquainted with but two instances of this peculiarity. One in the case of Squilla stylifera, and a second in a species of Gelasmus, or fiddler crab, described by Fritz Müller as occurring in Brazil. A third and very striking instance is found in Callinectes (Neptunus) hastata, the common edible crab of our southern coast. There are a number of differences in the shape of the two sexes, but besides these they present a marked difference in color. This color variation is confined to the first pair of thoracic appendages, the pair bearing the large chelae. These appendages are of a yellowish brown on the upper surface, a whitish yellow on the outside and of a brilliant blue on the inside and particularly at those parts which are protected from the light when the appendage is folded. It would seem therefore that this blue coloration was enhanced by not being exposed to light. The color of different individuals is tolerably constant and uniform.

Between the colors of the male and female appendage considerable differences are discernable. The most noticeable difference is that the male appendage appears remarkably blue when compared with the female. This is due partly to the fact that the amount of blue surface in the male is much greater than in the female, and partly to the fact that the blue color is of a much more brilliant hue. The blue color in the male extends nearly to the tips of the two fingers of the chelae, both the finger-like process of the propodite and the dactylopodite being largely colored blue. The very tips are, however, of a brilliant purple. In the female these parts are of an orange hue with not a trace of blue about them. Its tips are also colored purple but not so brilliant a purple as is found in the male. In the male the blue color extends partly upon the outer surface. In the female it is confined to the inner surface and only extends to the base of the dactylopodite. The outer surface of the dactylopodite and of the finger-like process of the propodite are in the male white, while in the female they are reddish orange. Upon the male appendage there is no orange color as a rule.

These differences in color are in all cases very marked, and will always serve to distinguish a male from a female appendage. No color differences are seen in any part of the crab except upon the first pair of appendages, and it is interesting to note that this sexual difference does not make its appearance till the crab reaches maturity. The chelae of immature males and females cannot be distinguished from each other. Fritz Müller says that the same is true of the Gelasmus species observed by him. On the other hand, considering the habits of Crustacea, these sexual differences can hardly be considered as the results of sexual selection.

Experiments upon the Heart of the Dog with reference to the Maximum Volume of Blood sent out by the Left Ventricle in a Single Beat, and the Influence of Variations in Venous Pressure, Arterial Pressure, and Pulse Rate upon the Work done by the Heart, by W. H. HOWELL *and* F. DONALDSON, JR.

[Abstract reprinted from the Proceedings of the Royal Society of London, No. 226, 1883].

Owing to the indirectness of the methods hitherto used for estimating the quantity of blood pumped out from the left ventricle at each systole, this important factor in all calculations of the work done by the heart has never been satisfactorily determined. Volkmann, and afterwards Vierordt, from calculations based upon the mean velocity of the stream of blood in the unbranched aorta, obtained the fraction $\frac{1}{100}$ as representing the ratio between the weight of blood thrown out at each systole and the body-weight. Fick, from data obtained by placing the arm in a plethysmograph, arrived at a much smaller fraction, $\frac{1}{1000}$. In our investigation we have made use of the dog's heart, completely isolated from all other organs of the body, with the exception of the lungs, after the method devised by Professor Martin. By this method it is possible to estimate directly the quantity of blood ejected from the left ventricle at each systole.

With regard to the maximum quantity of blood which can be thrown out from the left ventricle at a single systole, the general result of the experiments may be stated as follows: With a mean pulse rate of 180 per minute, the mean ratio of the maximum weight of blood pumped out from the left ventricle at each systole to the body weight is $\frac{1}{585}$ or .0017. In one experiment in which the pulse rate was 120 per minute, about the normal rate, the ratio obtained was $\frac{1}{700}$ or .0014. In applying these results to the normal dog, we believe that the average quantity of blood pumped out from the left ventricle at each systole in the living dog, is approximated most closely in the experiments given by the maximum outflow obtained from the isolated heart.

Variations of arterial pressure, from 58 to 147 millims. of mercury, were found to have no direct effect whatever upon the quantity of blood sent out from the left ventricle at each systole. Since the pulse rate is not altered, the work done by the left ventricle varies directly as the arterial pressure against which it works, within the limits named. For how much wider limits than those given this may hold true was not determined. There is every reason to believe that under normal conditions the force of the systole is more than sufficient to completely empty the ventricular cavity, and since, with arterial pressures from 58 to 147 millims., the quantity of blood ejected at each systole remains constant, it seems probable that within these limits, at least, the force of the ventricular contraction is not influenced by variations in arterial pressure, but remains maximal throughout.

Variations of venous pressure on the right side of the heart influence in a marked manner the outflow from the left ventricle. As the general result of the experiments it was found that the outflow from the left ventricle, and consequently the work done by it, increases with the venous pressure, but not proportionally, up to the point of maximum work.

Variations in the rate of beat of the heart were obtained by heating or cooling the blood supplied to it. The general result may be stated as follows: A diminution of pulse rate, brought about by lowering the temperature of the blood flowing into the heart, causes an increase in the quantity of blood thrown out from the ventricle at each systole, and consequently an increase in the work done at each systole, and vice versâ. The changes in the outflow from the ventricle at each systole are not, however, inversely proportional to the changes in the pulse rate. The total outflow, and, therefore, the total work done during any given period of time, decreases with a diminished pulse rate, and increases with an increased pulse rate.

NOTES IN PHILOLOGY.

On the Exemplar of Cod. C in the Apocalypse, by J. R. HARRIS.

[Abstract of a paper read before the University Philological Association, October 5, 1883].

In the Introduction to Westcott's and Hort's New Testament, the following remarks are made:

"The transition from small portable MSS. of limited contents is strikingly illustrated by a fortunate accident in the transcription of one of the four great comprehensive MSS. which are the earliest now extant. In the MS. of the Apocalypse from which C was taken some leaves had been displaced, and the scribe of C did not discover the displacement. It thus becomes easy to compute that each leaf of the exemplar contained only about as much as ten lines of the present edition; so that this one book must have made up nearly 120 small leaves of parchment, and accordingly formed a volume to itself or without considerable additions."

I propose to see how far the above suggestions will enable us to transfer the text of C into the pages of the exemplar.

The manuscript of C runs on smoothly enough to the end of the eighth page, (pages 5 and 6 being lost), after which another leaf is absent containing pages 9 and 10. Both of these lost leaves seem to correspond in compass with the omitted text. Page 11 then follows, and after some lines of page 12, we are abruptly carried back from c. x. 10 to c. vii. 17 so that the text runs as follows:

καὶ ἦν ἐν τῷ στόματί
μου ὡς μέλι γλυκύ . καὶ ὅτε ἔ δάκρυον ἐκ τῶν ὀφθαλ
μῶν αὐτῶν κτέ

The scribe continues on the new strain until the close of viii. 4: when he returns as abruptly as he departed; but not, be it observed, to the place he left, but to c. xi. 8, more advanced by about 10 lines of Westcott and Hort's text, so that the manuscript runs

ἐκ χειρὸς τοῦ ἀγγέλου ἐνώπιον τοῦ θεοῦ χιλίας
διακοσίας ἑξήκοντα

After this the text runs on smoothly, with the loss of certain of its leaves to the end of the book.

Evidently the passage inserted and the passage omitted are each of them pages of the exemplar. Moreover, since the lost leaves in which the transposed passage vii. 17–viii. 4. ought to have been found, correspond in compass to the missing text, it is evident that the two leaves of the exemplar with which we are concerned have been transposed.

Now with regard to the size of these leaves, let us employ as our measuring line, for convenience, a sixteen-syllabled hexameter, and let the text have the abbreviations that commonly belong to the words *θεὸς ἰησοῦς χριστὸς κύριος πνεῦμα* and *οὐρανός*. The two leaves of the exemplar will then be found to be 11 and 10.5 verses respectively.

If the writing had been perfectly even we should be able at once to form the roll of the exemplar by the process of subdivision; for from i. 1 to vii. 17 is evidently an exact number of pages, and from viii. 4 to x. 10 is also an exact number of pages. But the pages not being perfectly uniform, we must adopt the method of averages.

We have, then, from i. 1 to vii. 17 by actual measure 373.5 verses, and from viii. 4 to x. 10 we have 134.3 verses; and if the average page be just over 11 verses, this would give 33 pages up to the first transposed leaves and 12 pages between the two variable leaves. The total would, upon the same supposition be 1213.3 verses, or about 110 complete pages.

Now there is a very curious piece of transcriptional evidence which seems to show that not only C, but the first four or five verses of the Sinaitic codex were copied in the Apocalypse from a roll of this character.

For Tischendorf notes that the first few verses of the book down to *καὶ ἀπὸ ἰῦ χῦ* in c. i. 5 were copied by a different scribe to the rest of the book, the same scribe, viz., who wrote six other conjugate leaves in the New Testament. The evidence for this statement consists in peculiar forms of the letters and in the use of the apostrophus at the close of lines.

Assuming, as I think we may, the accuracy of Tischendorf's judgment, we can hardly avoid the conclusion that the portion of the book copied by the scribe was a single page of the exemplar, since he stops in the very midst of a sentence in the text, and at an irregular point in his own column.

Examination of the portion of the text in question shows it to be 11.3 verses, or almost exactly the same as we were led to adopt as the average page in Codex C. It seems, therefore, that both these copies are derived from similarly written exemplars, and I think we may say that towards the restoration of this exemplar we have the 1st, 34th and 47th pages accurately defined, and the remaining pages to a close degree of approximation.

I see no reason to assume that this was a parchment book; it has every appearance of being an ordinary paper-roll.

I can see nothing in the text to account for the transposition of the two pages.

The reconstructed roll may perhaps, by the study of its parallel columns, help to explain some of the many curious variants in the text of the Apocalypse.

On Certain Irregular Vedic Subjunctives or Imperatives, by MAURICE BLOOMFIELD.

[Abstract of a paper read before the University Philological Association, October 5, 1883].

The Vedic forms referred to are those of the types *stota, guhóta, kṛṇóta; étana; kárta, íyarta; gánta; dádāta; unátta* — appearing at first sight to be so-called 'improper subjunctives,' but having irregularly strong stem-forms with accent on the stem, instead of on the ending. No real attempt has been previously made to explain them.

In looking over the subjunctives with mode-sign *a*, and secondary endings, we shall be struck by the fact, that the 2d and 3d dual and especially the 2d plural, are entirely unrepresented. The exclusion of so important a case as the 2d plural from an otherwise well-developed category is *a priori* improbable. It is very probable that just here must be sheltered such forms as *punàta* and *dádāta*, which are in all respects regular subjunctives, save that their ending is secondary. And this furnishes the key for the others also.

If we look over the subjunctive forms possible from a stem *çṛṇu*, for example, we find *çṛṇutá, çṛṇávatha* and **çṛṇávata*, it is seen at once why an additional form was needed: none of these, being of three or four light syllables, is fit for use in strictly iambic cadence. Nothing is more natural than that the least usable among them, **çṛṇávata* (since *th* at least occasionally makes position), should be remodelled. Accordingly forms like *çṛṇóta, juhóta, étana, kárta*, etc., are to be regarded as contracted or apostrophized from the hypothetical *çṛṇávata, juhávata*, etc. This may be urged with especial emphasis for the *o*-forms; for the metrical correlation of *ava* and *o* is established by many instances, which cannot be impugned. Thus the weak stem *maghon-* for *maghavan-*, *gávas* to be read for *gós; stonte* to be read for *stavante*, etc. Compare the contraction of *aya* in the causative to *e* in *Prākrit;* also *ava* at the beginning of words in Pāli. Cases in which original etymological *ara* and *ana* become *ar* and *an* are not, to be sure, found; but extensions of *ar* or *ra* to two syllables are well-known; and cases have been pointed out, in which *na* is to be read as *ana*.

MATHEMATICAL NOTES.

On Quaternions, Nonions, Sedenions, etc., by J. J. SYLVESTER.

1°. Suppose that m and n are two matrices of the second order.

Then if we call the determinant of the matrix $x + my + nz$,

$$x^2 + 2bxy + 2cxz + dy^2 + 2eyz + fz^2,$$

the necessary and sufficient conditions for the subsistence of the equation $nm = -mn$ is that $b = 0$, $c = 0$, $e = 0$, and if we superadded the equations $m^2 + 1 = 0$, $n^2 + 1 = 0$, then $d = 1$ and $f = 1$, or in other words in order to satisfy the equations $mn = -nm$, $m^2 = -1$, $n^2 = -1$, where it will of course be understood that in these (as in the equations $m^2 + 1 = 0$, $n^2 + 1 = 0$) 1 is the abbreviated form of the matrix $\begin{smallmatrix}1&0\\0&1\end{smallmatrix}$ and $\bar{1}$ of the form $\begin{smallmatrix}\bar{1}&0\\0&\bar{1}\end{smallmatrix}$, the necessary and sufficient condition is that the determinant of $x + my + nz$ shall be equal to $x^2 + y^2 + z^2$.

The simplest mode of satisfying this condition is to write $m = \begin{smallmatrix}i&0\\0&-i\end{smallmatrix}$, $n = \begin{smallmatrix}0&\bar{1}\\\bar{1}&0\end{smallmatrix}$, i meaning $\sqrt{-1}$, which gives $mn = \begin{smallmatrix}0&i\\i&0\end{smallmatrix}$ and $nm = \begin{smallmatrix}0&i\\i&0\end{smallmatrix}$.

It is easy to express any matrix of the second order as a linear function of 1 $\left(\text{meaning } \begin{smallmatrix}1&0\\0&1\end{smallmatrix}\right)$ m, n, p, where p stands for mn.

For if $\begin{smallmatrix}a,&b\\c,&d\end{smallmatrix}$ be any such matrix it is only necessary to write

$$a = f + ig, \quad b = -h - ki,$$
$$d = f - ig, \quad c = -h + ki,$$

and then $\begin{smallmatrix}a,&b\\c,&d\end{smallmatrix} = f + gm + hn + kp$.

The most general solution of the equations $MN = NM$, $M^2 = N^2 = -1$, must contain 8 arbitrary constants, viz., the difference between the number of terms in m and n, and the number of conditions $b = 0$, $c = 0$, $e = 0$, $d = 1$, $f = 1$, which are to be satisfied.

Suppose M, N to be the most general solution fulfilling these conditions; we may write

$$M = f + gm + hn + kp,$$
$$N = f' + g'm + h'n + k'p,$$

where m, n is any particular solution and $p = mn$, and we shall have inasmuch as $M^2 = \bar{1}$,

$$f^2 - g^2 - h^2 - k^2 + 2fgm + 2fhn + 2fkp = \text{the matrix } \bar{1},$$

and consequently

$$g^2 + h^2 + k^2 = 1 + f^2,$$
$$fg = 0, fh = 0, fk = 0.$$

Hence $f = 0$ and $g^2 + h^2 + k^2 = 1$.

Similarly $f' = 0$ and $g'^2 + h'^2 + k'^2 = 1$,

and also inasmuch as $MN = -NM$,

$$gg' + hh' + kk' = 0,$$

and since the equations $M^2 = \bar{1}$, $N^2 = 1$, $MN = -NM$ imply if we make $MN = P$ that $P^2 = -1$, and $MP = -PM$, and $NP = -PN$, it follows that M, N, P, are connected with m, n, p, in the same way as the coordinates of a point referred to one set of rectangular coordinates in space are connected with the coordinates of the same point referred to any other set of the same.*

Herein lies the ground of the geometrical interpretation to which quaternions lend themselves and it is hardly necessary to do more than advert to the fact that the theory of Quaternions is one and the same thing as that of Matrices of the second order viewed under a particular aspect.†

2°. Let m, n now denote matrices of the third order.

We might propose to solve the equation $mn = -nm$.

The result of the investigation is that we must have $m^2 = n^2$, $m^3 = 0$, $n^3 = 0$, and writing $mn = p$, $m^2 = n^2 = q$, there results a set of *quinions*, 1, m, n, p, q, for which the multiplication is that marked (a_5) p. 144 of the late Prof. Peirce's invaluable memoir in Vol. IV of the *American Journal of Mathematics*.

But instead of this let us propose the equation $mn = \rho nm$, where ρ is one of the imaginary roots of unity; if now we write the determinant of $x + my + nz$ under the form

$$x^3 + 3bx^2y + 3cx^2z + 3dx^2z + 6exyz + 3fy^2z + gy^3 + 3hy^2z + 3kyz^2 + lz^3,$$

it may be shown that we must have

$$b = 0, \quad c = 0, \quad d = 0, \quad e = 0, \quad f = 0, \quad h = 0, \quad k = 0,$$

and if we superadd the conditions $m^3 = 1$, $n^3 = 1$, we must also have $g = 1$, $l = 1$, or in other words the determinant to $x + my + nz$ must take the form $x^3 + y^3 + z^3$; but this condition (or system of conditions) although necessary *is not sufficient* (a point which I omitted to notice in my article entitled "A Word on Nonions" inserted in a previous *Circular*).

It is obviously necessary that we must have $(mn)^3 = 1$.

Now if the *identical equation* to mn, be written under the form

$$(mn)^3 - 3B(mn)^2 + 3Dmn - E = 0,$$

B may be shown to be a linear homogeneous function of b, c, and e; also $E = gl = 1$; but D is not a function of b, c, d, e, f, g, h, k, l, and will not in general vanish (as it is here required to do) when b, c, d, e, f, h, k vanish. Its value is the sum of the products obtained on multiplying each quadratic minor of m by its *altruistic* opposite in n: [the *proper* opposite to a minor of m means the minor which is the reflected image of such minor viewed in the Principal Diagonal of m regarded as a mirror; and the *altruistic* opposite is the minor which occupies in n a position precisely similar to that of the proper opposite in m]. There are, therefore, 10 equations in all to be satisfied between the coefficients of m and n when $m^3 = n^3 = 1$ and $nm = \rho mn$.

These *ten* conditions I have demonstrated are *sufficient* as well as necessary. There remains then 18 — 10 or 8 arbitrary constants in the general solution. If m, n is a particular solution we may take for M, N (the matrices of the general solution),

$$M = a + \beta m + \gamma m^2 + a'n + \beta' mn + \gamma' m^2 n + a''n^2 + \beta'' mn^2 + \gamma'' m^2 n^2,$$
$$N = a_1 + \beta_1 m + \gamma_1 m^2 + a'_1 n + \beta'_1 mn + \gamma'_1 m^2 n + a''_1 n^2 + \beta''_1 mn^2 + \gamma''_1 m^2 n^2,$$

and 10 relations between the 18 coefficients *must* be sufficient to enable to be satisfied the equations $M^3 = N^3 = 1$, $NM = \rho MN$: but what these relations are and how they may most simply be expressed I am not at present in a condition to state.*

I showed in "A Word on Nonions" that the 9 first conditions are satisfied by taking

$$m = \begin{smallmatrix}1&0&0\\0&\rho&0\\0&0&\rho^2\end{smallmatrix}, \qquad n = \begin{smallmatrix}0&0&1\\\rho&0&0\\0&\rho^2&0\end{smallmatrix}.$$

The 10th condition is also satisfied; for the only quadratic minors (not having a zero determinant) in m are $\begin{smallmatrix}1&0\\0&\rho\end{smallmatrix}$, $\begin{smallmatrix}\rho&0\\0&\rho^2\end{smallmatrix}$, $\begin{smallmatrix}1&0\\0&\rho^2\end{smallmatrix}$; the *altruistic opposites* to which in n are $\begin{smallmatrix}0&\rho\\0&0\end{smallmatrix}$, $\begin{smallmatrix}0&\rho^2\\0&0\end{smallmatrix}$, $\begin{smallmatrix}0&0\\1&0\end{smallmatrix}$, the determinants to each of which are zeros, and accordingly we find

$$m^3 = n^3 = \begin{smallmatrix}1&0&0\\0&1&0\\0&0&1\end{smallmatrix},$$

$$mn = \begin{smallmatrix}0&0&\rho^2\\\rho&0&0\\0&1&0\end{smallmatrix}, \qquad nm = \begin{smallmatrix}0&0&1\\\rho^2&0&0\\0&\rho&0\end{smallmatrix},$$

so that $nm = \rho mn$ and $m^3 = n^3 = 1$ as required.

I subjoin an outline proof of the fundamental portion of the theory of Quaternions and Nonions above stated as it will serve to throw much light upon the nature of the processes employed in that new world of thought to which I gave the name of Universal Algebra or the Algebra of multiple quantity: a fuller explanation will be found in the long memoir which I am preparing on the entire subject for the *American Journal of Mathematics*.

1°. As regards the equation $nm = -mn$ where m, n, are matrices of the second order.

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*There is another solution possible, obtained by writing $-\frac{f}{f} = \frac{g}{g} = \frac{h}{h} = \frac{k}{k}$, $f^3 + g^3 + h^3 + k^3 = 0$ but this leads to a linear relation between m and n, so that $mn = nm$ and consequently $mn = nm = 0$ which is not the kind of solution proposed in the question.

†See my article in the Lond. and Edin. Phil. Mag. on "Involution and Evolution of Quaternions," November, 1883.

*The solution of this problem would seem to involve some unknown expansion of the idea of orthogonalism. Unless $MN = NM = 0$, a solution to be neglected, it may be proved that $a = 0$, $a_1 = 0$.

As before let the determinant of $(x+ym+zn)=x^2+2bxy+2cxz+dy^2+2eyz+fz^2$.

[I may observe here parenthetically that the Invariant of the above Quantic is equal to the determinant of $mn-nm$, and that when it vanishes $1, m, n, mn$, as also $1, n, m, nm$ are linearly related—or, as I express it, this Invariant is the Involutant of the system m, n or n, m. When m, n are of higher than the second order, the Involutant of m, n, say I, is that function whose vanishing implies that the 9 matrices $(1, m, m^2)(1, n, n^2)$ are linearly relatent, and the Involutant of n, m, say J, that function whose vanishing implies that the 9 quantities $(1, n, n^2)(1, m, m^2)$ are so related (I, J being two distinct functions) and so for matrices of any order higher than the second].

By virtue of a general theorem for any two matrices m, n of the second order, the following identities are satisfied:

$$m^2-2bm+d=0,$$
$$mn+nm-2bn-2cm+2e=0,$$
$$n^2-2cn+f=0.$$

If then $mn+nm=0$, since m and n cannot be fractions of one another (for then $mn=nm$), the second equation shows that $b=0, c=0, e=0$, and conversely if $b=0, c=0, e=0$, $mn+nm=0$, and $m^2+d=0$, $n^2+f=0$, where, if we please, we may make $d=1, f=1$.

2°. Let m, n be matrices of the third order, and write as before,

$$\text{Det. } (x+ym+zn)=x^3+2bx^2y+2cx^2z+dxy^2+2exyz+fxz^2+gy^3+3hy^2z+3ky^2z+lz^3.$$

Then by virtue of the general theorem last referred to there exist the identical equations

$$m^3-3bm^2+3dm-g=0,$$
$$m^2n+mnm+nm^2-3b(mn+nm)-3cm^2+3dn+3em-3h=0,$$
$$mn^2+nmn+n^2m-3c(mn+nm)-3bn^2+3fm+3en-3k=0,$$
$$n^3-3cn^2+3fn-l=0.$$

Let now $nm=\rho mn$, where ρ is either imaginary cube root of unity, then (1), $m^2n+mnm+nm^2=0$ and (2), $mn^2+nmn+n^2m=0$; for greater simplicity suppose also that $m^3=n^3=1$, where 1 means the matrix $\begin{matrix}1&0&0\\0&1&0\\0&0&1\end{matrix}$.

From the 1st and 2d of the 4 identical equations combined it may be proved that $b=0, d=0$; [I do not produce the proof here because to make it *rigorous*, the theory of Nullity would have to be gone into which would occupy too much space] and in like manner from the 3d and 4th it may be shown that $c=0, f=0$*. Hence returning to the two middle equations it follows that $e=0, h=0, k=0$, and from the two extremes that $g=1, l=1$.

If then $mn=\rho nm$, $m^3=1$, and $n^3=1$, it is necessary that

$b=0,\ c=0,\ d=0,\ e=0,\ f=0,\ g=1,\ h=0,\ k=0,\ l=1.$

But these equations although not necessary are manifestly insufficient; for they lead to the equations $m^3-1=0, n^3-1=0$, and (1) $m^2n+mnm+nm^2=0$; (2) $mn^2+nmn+n^2m=0$, but not necessarily to $nm=\rho mn$. In fact the supposed equations between m and n involve as a consequence the equation $(mn)^3=1$. Now the general identical equation to (mn) is

$$(mn)^3+3B(mn)^2+3D(mn)+F=0,$$

where $B=$ The sum of each term in m by its altruistic opposite in $n=3bc-2e=0$, $F=gl=1$, and $D=$ The sum of each first minor in m by its altruistic opposite in n which sum does not necessarily vanish when b, c, d, e, f, h, k, all vanish. Hence there is a 10th condition necessary not involved in the other 9, viz., $D=0$. These 10 conditions I shall show are sufficient as well as necessary. For when they are satisfied since $(mn)^3=1$, $mn.mn=n^2m^2$.

Hence from (1) $m^2n^2+n^2m^2+nm^2n=0$,
and from (2) $m^2n^2+n^2m^2+mn^2m=0$.
Hence $nm.mn=mn.nm$,† and consequently nm is a function of mn. Hence we may write $nm=A+Bmn+C(mn)^2$.

But the *latent roots* of mn and nm (which are always identical) are $1, \rho, \rho^2$, hence $A+B+C$, $A+B\rho+C\rho^2$, $A+B\rho^2+C\rho$, must be equal to $1, \rho, \rho^2$, each to each taken in some one of the 6 orders in which these quantities can be written.*

Solving these 6 systems of linear equations there results:

$$A=0,\quad B=0,\quad C=1, \rho \text{ or } \rho^2,$$
or
$$A=0,\quad B=1, \rho \text{ or } \rho^2,\quad C=0.$$

Hence $nm=\theta mn$, or $\theta(mn)^2$ where $\theta=1, \rho, \rho^2$.

If $nm=\theta(mn)^2$, $nmmn=\theta(mn)^3=0$.

Hence $m^2=\theta n^2.\theta n^2=\theta^2 n$; and

$$m^2n+mnm+nm^2=3\theta m^4=3\theta m=0,$$

so that $m=0$, and $m^3=0=1$; and again if $nm=mn$,

$$m^2n+mnm+nm^2=2m^2n+mnm=3m^2n=0,$$

so that $m^2n=0$, $n=0$, and $n^3=0=1$ as before, where it should be noticed that $0=1$ means that $\begin{matrix}0&0&0\\&&\\&&\end{matrix}$ is identical with $\begin{matrix}1&0&0\\0&1&0\\0&0&1\end{matrix}$.

Hence the only available hypothesis remaining is the equation $nm=v.mn$, where v is one of the imaginary cube-roots of unity as was to be proved.

3°. It remains to say a few words on the general equation $nm=kmn$, where m, n are matrices of any order ω. To avoid prolixity I shall confine my remarks to the general case, which is, that where the determinants (or as I am used to say the contents) of m and n are each of them finite; with this restriction, the proposed equation is impossible for general values of k as will be at once obvious from the fact that the totalities of the latent roots of mn and of nm are always identical, but the individual latent roots are by virtue of the proposed equation in the ratio to one another of $1:k$, which, since by hypothesis no root is zero, is only possible when $k^\omega=1$.

When the above equation is satisfied the ω^2 equations arising from the identification of nm with kmn cease to be incompatible and (as is necessary or at all events usual in such a contingency) become mutually involved. Thus, *ex. gr.*, when $\omega=1$ and $k=1$, the number of independent equations is 0, *i. e.* $1-1$, when $\omega=2$ and $k=-1$ the number is 3, *i. e.* $4-1$, when $\omega=3$ and $k=\rho$ or ρ^2 the number is 8, *i. e.*, $9-1$; it is fair therefore to presume (although the assertion requires proof) that for any value of ω when k is a primitive ωth root of unity the number of conditions to be satisfied when $nm=kmn$ is ω^2-1. Of these the condition that the content of $x+my+nz$ shall be of the form $x^3+cy^3+c'z^3$ will supply $\frac{(\omega+1)(\omega+2)}{2}-3$, *i. e.* $\frac{\omega^2+3\omega}{2}-2$, and there will therefore be $\frac{\omega^2-3\omega}{2}+1$ or $\frac{(\omega-1)(\omega-2)}{2}$ to be supplied from some other source.

When k is a non-primitive ωth root of unity, the number of equations of condition is no longer the same. Thus when $k=1$ we know that n may be of the form $A+Bm+Cm^2+\ldots Lm^{\omega-1}$, where $A, B, \ldots L$, and all the ω^2 terms in m are arbitrary, and consequently the number of conditions for that case is $2\omega^2-(\omega^2+\omega)$ or $\omega^2-\omega$. It seems then very probable that if k is a qth power of a primitive ωth root of unity the number of conditions required to satisfy $nm=kmn$ is $\omega^2-\delta$ where δ is the greatest common measure of q and ω: but, of course, this assertion awaits confirmation.

When $\omega=4$ besides the case of $nm=mn$, *i. e.* of n being a function of m of which the solution is known there will be two other cases to be considered, viz. $nm=-mn$ and $nm=imn$: the former probably requiring 14 and the latter 15 conditions to be satisfied between the coefficients of m, the coefficients of n and the two sets of coefficients combined.

It is worthy of notice that the conditions resulting from the content of $x+my+nz$ becoming a sum of 3 powers are incompatible with the equation $nm=vmn$ when v is other than a primitive ωth root of unity (ω being of course the order of m or n).

Thus suppose $\omega=4$; the conditions in question applied to the middle one of the 5 identical equations give

$$m^2n^2+n^2m^2+mn^2m+nm^2n+mnmn+nmnm=0;$$

when $nm=imn$ the left hand side of this equation becomes $(1+i^4+i^2+i^2+i+i^3)m^2n^2$, *i. e.* is zero, but when $nm=-mn$, the value is $(1+1-1-1-1-1)m^2n^2$ which is not zero, and so in general. Thus the pure power form of the content of $x+my+nz$ is a condition applicable to the case of $\frac{nm}{mn}$ being a primitive root of unity and to no other.

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* Except when m, n are functions of one another, so that mn and nm are identical and consequently are each of them zero.

† This equation is independent of the equation $(mn)^3=1$; for $nm^2n-mn^2m=(m^2n+mnm+nm^2)n-m(mn^2+nmn+n^2m)=0$ by virtue of equations (1) and (2) above: accordingly these equations taken alone imply the equations $nm=A+B_1mn+C(mn)^2$, $mn=-A+B_2nm-C(nm)^2$ where B_1, B_2 are the roots of $B^2+B+1-\frac{AC}{2}=0$; A, C being arbitrary and independent except that each vanishes when and only when the cube of mn and (as a consequence) of nm, is a scalar matrix.

* By virtue of the general theorem that the latent roots of any function of a matrix are the like functions of the latent roots of the original matrix.

The case of nm being a primitive root of ordinary unity is therefore the one which it is most interesting to thrash out.

There are in this case we have seen $\frac{\omega^2+3\omega-4}{2}$ simple conditions expressible by the vanishing of that number of coefficients in the content of $x+my+nz$ and $\frac{(\omega-1)(\omega-2)}{2}$ supplemental ones. What are these last? I think their constitution may be guessed at with a high degree of probability. For revert to the case of $\omega=3$ in which there is one such found by equating to zero the second coefficient in the identical equation

$$(mn)^3-3B(mn)^2+3Dmn-G=0.$$

Suppose now $(m^2n^2)^3-3B'(m^2n^2)^2+3D'm^2n-G'=0$ is the identical equation to m^2n^2. By virtue of the 8 conditions supposed to be satisfied we *know* that $nm=\rho mn$ as well as $m^3=1$, $n^3=1$, and consequently that $(m^2n^2)^3=1$. Hence $B'=0$, $D'=0$, by virtue of the 7 parameters in the oft-quoted content and of D being all zero, and thus the evanescence of B' or D' imports no new condition.

Now suppose $\omega=4$, and that

$$(mn)^4-4B(mn)^3+6D(mn)^2-4Gmn+M=0,$$
$$(m^2n^2)^4-4B'(m^2n^2)^3+6D'(m^2n^2)^2-4G'm^2n^2+M'=0.$$

Here we know that B vanishes by virtue of bc and e vanishing, but $D=0$, $G=0$, which must be satisfied if $nm=imn$ will be two new conditions not implied in those which precede. It seems then although not certain, highly probable that $B'=0$, $D'=0$, will be implied in the satisfaction of the antecedent conditions but that $G'=0$ will be an independent condition, so that $D=0$, $G=0$, $G'=0$, will be the three supplemental conditions: and again when $\omega=5$ forming the identical equations to mn, m^2n^2, m^3n^3, and using an analogous litteration to what precedes, the supplemental conditions will be $D=0$, $G=0$, $M=0$,

$$G'=0,\ M'=0,$$
$$M''=0, \text{ and so in general for any value of } \omega.$$

The functions D, G, M, etc, above equated to zero are known from the following theorem of which the proof will be given in the forthcoming memoir.*

If $(\overline{mn})^\omega+k_1(\overline{mn})^{\omega-1}+\ldots+k_i(\overline{mn})^{\omega-i}+\ldots=0$ is the *identical equation* to mn, then k_i is equal to the sum of the product of each minor of order i in m multiplied by its *altruistic* opposite in n.

The annexed example will serve to illustrate in the case of $\omega=3$ that unless the supplemental condition is satisfied we cannot have $nm=\rho mn$.

Write
$$m=\begin{matrix}1&0&0,\\0&\rho&0,\\0&0&\rho^2,\end{matrix}\qquad n=\begin{matrix}0&c&k,\\k&0&c\rho,\\c\rho^2&k&0,\end{matrix}$$

then the determinant to $x+my+nz$ will be easily found to be $x^3+y^3+(c^3+k^3)z^3$; but D becomes $-3\rho ck$, and does not vanish unless $c=0$ or $k=0$, and accordingly we find

$$mn=\begin{matrix}0&\rho c&\rho^2k,\\k&0&c,\\\rho^2c&\rho k&0,\end{matrix}\qquad nm=\begin{matrix}0&c&k,\\\rho k&0&\rho^2c,\\\rho c&\rho^2k&0.\end{matrix}$$

When $k=0$ $mn=\rho^2nm$, when $c=0$ $nm=\rho mn$, but on no other supposition will $\frac{nm}{mn}$ be a primitive cube root of unity.

ADDENDUM.

Referring to the equation $MN=-NM$, and to the eight equations expressing M and N in terms of the combinations of the powers of m with those of n [in which it is to be understood that M and N are *non-vacuous*], we know that the sums of the latent roots of M and of N must each vanish and consequently, as may be proved, that $a=0$, $a'=0$, leaving $8-2$ or 6 conditions to be satisfied. If we further stipulate that $M^3=1$, $N^3=1$, there will be 8 relations connecting the coefficients $b, c, \ldots k$ and $b', c', \ldots k'$, so that the 64 coefficients in the 8 equations connecting M, M^2; N, N^2; MN, M^2N^2; M^2N, MN^2, or say rather M, M^2; N, N^2; ρ^2MN, $\rho^2M^2N^2$; ρM^2N, ρMN^2, with like combinations or multiples of combinations of powers of m, n† will be connected together by 56 equations; the coefficients in the expression for any one of the above 8 terms may then be arranged in pairs f_i, f_i'; g_i, g_i'; h_i, h_i'; k_i, k_i'; and in the expression for its fellow by F_i, F_i'; G_i, G_i'; H_i, H_i'; K_i, K_i'; so that the Matrix is resolved as it were into 4 sets of paired columns and 4 sets of paired lines; the 4 different sets of paired lines being found by writing successively $i=1, 2, 3, 4$.

It is then easy to see that there will be 4 equations of the form

$$\Sigma(f_\alpha G_\alpha'+f_\alpha G_\alpha')=1,$$

and 6 quaternary groups of (*i. e.* 24) equations of the form

$$\Sigma(f_\alpha G_\beta'+f_\alpha G_\beta')=0$$

[with liberty to change f into F or G into g or each into each]: together then the above are 28 of the 56 conditions required. But inasmuch as the 8 $[m, n]$ arguments may be interchanged with the 8 $[M, N]$ ones; we may transform the above equations by substituting for each letter f its conjugate $\frac{d\log\Delta}{df}$ (where Δ is the content of the Matrix) and thus obtain 28 others, giving in all (if the two sets as presumably is the case) are independent the required 56 conditions: the latter 28, however, may be replaced by others of much simpler form.*

To me it seems that this vast new science of multiple quantity soars as high above ordinary or quaternion Algebra as the Mécanique Céleste above the "Dynamics of a Particle" or a pair of particles, (if a new Tait and Steele should arise to write on the Dynamics of such pair,) and is as well entitled to the name of Universal Algebra as the Algebra of the past to the name of Universal Arithmetic.

On Involutants and other allied species of Invariants to Matrix Systems, by J. J. SYLVESTER.

To make what follows intelligible I must premise the meaning and laws of vacuity and nullity.

A matrix is said to be vacuous when its content (the determinant of the matrix) is zero, but it may have various degrees of vacuity from ω up to ω the order of the matrix.

If to each term in the principal diagonal of a matrix λ be subtracted, the content of the resulting matrix is a function of degree ω in λ; the ω values of λ which make this content vanish are called its latent roots, and if i of these roots are zero, the vacuity (treated as a number) is said to be i. This comes to the same thing as saying that the vacuity is i when the determinant, and the sums of the determinants of the principal minors of the orders $\omega-1$, $\omega-2$, $\ldots$ $(\omega-i+1)$ are each zero. A principal minor of course means one which is divided into 2 triangles by the principal diagonal of the parent matrix.

Again the nullity is said to be i when *every* minor of the order $(\omega-i+1)$ [and consequently of each superior order] is zero. It follows therefore that it means the same thing to predicate a vacuity 1 and a nullity 1 of any matrix, but for any value of i greater than 1, a nullity i implies a vacuity i but not *vice versâ*; the vacuity may be i, whilst the nullity may have any value from 1 up to i inclusive.

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*This theorem furnishes as a Corollary the principle employed to prove the stability of the Solar System. (See Lond. and Edin. Phil. Mag., October, 1883.)

†It is easy to see that the sum of the latent roots of M^iN^j must be zero for all values of i, j so that it is a homogeneous linear function of the 8 quantities $m, m^2, \ldots, mn, m^2n^2$.

*I am still engaged in studying this matrix, which possesses remarkable properties Is it orthogonal? I rather think not, but that it is allied to a system of 4 pairs of somethings drawn in four mutually perpendicular hyperplanes in space of 4 dimensions. In the general case of $MN=\rho NM$ where ρ is a primitive ωth root of unity, there will be an analogous matrix of the order ω^3-1 where each line and each column will consist of $\omega+1$ groups of $\omega-1$ associated terms.

The value of the cube of any one of the 8 matrices $M, M^2; \ldots; MN, M^2N^2$ may be expressed as follows: It is P into ternary unity. [Such a quantity may be termed by analogy a Scalar.] To find P, I imagine the 8 letters corresponding to M^iN^j (but without powers of ρ attached) to be set over 8 of the 9 points of inflexion to any cubic curve the paired letters being made suitably collinear with the missing 9th point. Then among themselves the 8 letters may be taken in 8 different ways to form collinear triads and the product of the letters in each triad may be called a collinear product; P, i (which is identical with the Determinant to M^iN^j) will be the sum of the cubes of the 8 letters less 3 times the sum of their 8 collinear products, and its 8 values will be analogous to the 3 values of the sum of 3 squares in the Quaternion Theory. Each of these 8 values is assumed equal to unity.

It may be not amiss to add that the product of four squares by four is representable rationally as a sum of four squares, so if we place (not now 8 specially related but) nine perfectly abitrary letters over the nine points of inflexion of a cubic curve the sum of their 9 cubes less three times their 12 collinear products multiplied by a similar function of 9 other letters may be expressed by a similar function of 9 quantities lineo-linear functions of the two preceding sets of 9 terms.

By the 8 letters of any set as *ex. gr.* $b, \ldots, h'$ being "specialized," I mean that they are subject to the condition $bb'+dd'+ff'+hh'=0$. When this equation is satisfied, and not otherwise, M^3 will be a Scalar, and it *must* be satisfied when $MN=\rho NM$.

The law of nullity which I am about to enunciate is one of paramount importance in the theory of matrices.*

The law is that the nullity of the product of *two* (and therefore of any number of) matrices cannot be less than the nullity of any factor nor greater than the sum of the nullities of the several factors which make up the product.

Suppose now that $\lambda_1, \lambda_2, \ldots \lambda_\omega$ are the latent roots of any matrix with unequal latent roots of the order ω. It is obvious that any such term as $m-\lambda_1$, will have the nullity 1, for its latent roots will be $0, \lambda_2-\lambda_1, \lambda_3-\lambda_1, \ldots \lambda_\omega-\lambda_1$, and consequently its *vacuity* is 1.

Moreover we know from Cayley's famous identical equation that the nullity of the product of all the ω factors is ω.

Hence it follows that if M_i contains i, and M_j the remaining $\omega-i$ of these factors (so that $i+j=\omega$), the nullity of M_i must be exactly i and of M_j exactly j.

For the theorem above stated shows that M_i cannot have a nullity greater than i, nor M_j a nullity greater than j.

Hence if the nullity of the one were less than i or of the other less than j, the nullity of M_iM_j would be less than $i+j$, *i. e.* less than ω, whereas its nullity is ω; hence the two nullities are respectively i and j as was to be shown.

Furthermore we know that the latent roots of $(m-\lambda_1)^\alpha$ are $(\lambda_1-\lambda_1)^\alpha$; $(\lambda_2-\lambda_1)^\alpha; \ldots (\lambda_\omega-\lambda_1)^\alpha$.

Hence if the latent roots of m are all distinct, the nullity of $(m-\lambda_1)^\alpha$ is unity and consequently by the same reasoning as that above employed it follows that the nullity of $(m-\lambda_1)^{\alpha_1}.(m-\lambda_2)^{\alpha_2}\ldots(m-\lambda_i)^{\alpha_i}$ is exactly i.

I will now explain what is meant by the Involutant or Involutants of a system of two matrices of like order.

It will be convenient here to introduce the term "topical resultant" of a system of ω^2 matrices each of order ω.

We may denote any matrix say

$$\begin{matrix} a_{1,1}\, a_{1,2} \ldots a_{1,\omega} \\ a_{2,1}\, a_{2,2} \ldots a_{2,\omega} \\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot \\ a_{\omega,1}\, a_{\omega,2} \ldots a_{\omega,\omega} \end{matrix}$$

by the linear form

$$\begin{matrix} a_{1,1}\,t_{1,1} + a_{1,2}\,t_{1,2} + \ldots + a_{1,\omega}\,t_{1,\omega} \\ + a_{2,1}\,t_{2,1} + a_{2,2}\,t_{2,2} + \ldots + a_{2,\omega}\,t_{2,\omega} \\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot \\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot\ \cdot \\ + a_{\omega,1}\,t_{\omega,1} + a_{\omega,2}\,t_{\omega,2} + \ldots + a_{\omega,\omega}\,t_{\omega,\omega} \end{matrix}$$

where the t system is the same for all matrices of the order ω. If, then, we have ω^2 such matrices, their topical resultant is the Resultant in the ordinary sense of the ω^2 linear forms above written, proper to each of them respectively.

Suppose now that m, n are two independent matrices of the order ω, we may form ω^2 matrices by taking each power of m from 0 to $\omega-1$ as an antecedent factor, and can combine it with similar powers of n as a consequent factor and in this way obtain ω^2 matrices, of which the first will be the ω-ary unity, *i. e.* a matrix of the order ω in which the principal diagonal terms are all units and the other terms all zero. The topical resultant of these ω^2 matrices I shall for brevity denote as the Involutant to m, n.

In like manner, inverting the position of the powers of m and of n so as to make the latter precede instead of following the latter in the ω^2 products above referred to, we shall obtain another topical resultant which may be termed the Involutant to n, m.

The reason why I speak of these topical resultants as involutants to m, n or n, m is the following:

In general if m, n are two independent matrices, any other matrix p, by means of solving ω^2 linear equations, may obviously be expressed as a linear function of the ω^2 products $(1, m, m^2, \ldots; m^{\omega-1})(1, n, n^2, \ldots; n^{\omega-1})$. There are, however, exceptions to this fact.

The most obvious exception is that which takes place when n is a function of m; for then any ω of the ω^2 products will be linearly related, and there will be substantially only ω disposable quantities to solve ω^2 equations.

Another exception is when the m, n Involutant, *i. e.* the topical resultant of the ω^2 matrices is zero; in which case the general values of the ω^2 disposable quantities each becomes infinite. So that m, n may be said to be in a kind of mutual involution with one another. So, again, p may in general be expressed as a linear function of the ω^2 matrices $(1, n, n^2, \ldots; n^{\omega-1})(1, m, m^2, \ldots; m^{\omega-1})$, but when the n, m Involutant vanishes this is no longer possible.

When $\omega=2$ the two involutants, considered as definite determinants, are absolutely equal in magnitude and in Algebraical sign, but when ω exceeds 2 this is no longer the case; the two Involutants are then entirely distinct functions of the elements of m and n.

Thus to take a simple example: if $m=\begin{matrix}1&0&0\\0&\rho&0\\0&0&\rho^2\end{matrix}$ and $n=\begin{matrix}0&\rho&k\\k&0&\rho^2\\1&k&0\end{matrix}$ it will be found by direct calculation of two topical resultants of the 9th order, that the two involutants will be $81\,(\rho-\rho^3)(k^3-\rho)^3$ and $81\,(\rho^3-\rho)(k^3-\rho^3)^3$ respectively. The reason why the two involutants coincide in the case of $\omega=2$ is not far to seek. It depends upon the fact of the existence of the mixed identical equation $mn+nm-2bn-2cm+2e=0$; from which it is obvious that the topical resultant of $1, m, n, nn$ is the negative of that of $1, m, n, nm$ or identical with that of $1, n, m, nm$.

By direct calculation it will be found that the Involutant m, n, or n, m, where $m=\frac{fg}{hk}$ $n=\frac{f'g'}{h'k'}$ is

$$-(gh'-g'k)^2+\Big((f-k)g'-(f'-k')g\Big)\Big((f-k)h'-(f'-k')h\Big),$$

which is the same thing as the content of the matrix $(mn-nm)$. It may also be shown *à priori* or by direct comparison to be identical (to a numerical factor *près*) with the Discriminant of the Determinant to the matrix $(x+ym+zn)$ which is a ternary quantic of the second order. Its actual value is 4 times that discriminant.

Let us consider the analogous case of Mechanical Involution of lines in a plane or in space. There are two questions to be solved. The one is to find the condition that the Involution may exist, *i. e.*, that a set of equilibrating forces admit of being found to act along the lines; the second, to determine the relative magnitudes of the forces when the involution exists, and this is the simpler question of the two.

In like manner we may consider two questions in the case of m, n being in either of the two kinds of involution; the one being to find what the condition is of such involution existing, the other what are the coefficients of the ω^2 coefficients in the equation which connects the ω^2 products, when the involution exists.

This latter part of the question (surprising as the assertion may appear and is) admits of a very simple and absolutely general direct and almost instantaneous solution by means of the Law of Nullity, above referred to, as I will proceed to show.

The determination of the Involutants, or at all events of their product, will then be seen to follow as an immediate consequence from this prior determination of the form of the equations which expresses the involution of the two kinds respectively.

But first it may be well to explain why and in what sense I refer in the title to Involutants as belonging to a class of invariants. I say, then, that universally involutants are invariants in this sense, that if any function of m and any function of n, any function of m, or any function of n be substituted, the ratio of the two Involutants, say I and J, remains unaltered. By virtue of the Identical Equation $(m)^i$ will be of the form $A_i+B_i+C_im^2+\ldots+L_im^{\omega-1}$ and as a consequence it is easy to see that when m^i is substituted for m, I and J will become respectively PI, PJ where P is the ωth power of the determinant to the matrix formed by writing under one another the $(\omega-1)$ lines of terms, of which the line B_i, $C_i, \ldots; L_i$ is the general expression.

*The three cardinal laws or landmarks in the science of multiple quantity are (1) the laws of *nullity*, (2) the law of *latency*, viz., that if $\lambda_1, \lambda_2, \ldots \lambda_\omega$ are the latent roots of m, then $f\lambda_1, f\lambda_2, \ldots f\lambda_\omega$ are those of ρm including as a consequence that

$$fm=\Sigma f\lambda_1\frac{(\lambda-\lambda_2)(\lambda-\lambda_3)\ldots(\lambda-\lambda_\omega)}{(\lambda_1-\lambda_2)(\lambda_1-\lambda_3)\ldots(\lambda_1-\lambda_\omega)},$$

and (3) the law of *identity*, viz., that the powers and combinations of powers of two matrices m, n of the order ω are connected together by $(\omega+1)$ equations whose coefficients are all included among the coefficients of the determinant to the Matrix

$$x+ym+zn.$$

Moreover, in the particular case where $\omega = 2$ and $I = J$* besides being an Invariant in this modified sense I will be an invariant in a sense including but transcending the more ordinary conception of an Invariant; for if when for m and n $f(m, n)$ $\phi(m, n)$ are substituted I becomes I', then I' will contain I as a factor; this is a consequence of the fact that when m and n are in involution $f(m, n)$ and $\phi(m, n)$ will also be in involution, for in consequence of the identical equation $mn + nm - 2bn - 2cm + 2s = 0$ f and ϕ and $f\phi$ will each be reducible to the forms $A + Bm + Cn + Dmn$ and it is obvious from the ordinary theory of the determinants that the topical resultant of 1, $\left[\text{meaning } \begin{smallmatrix} 1 & 0 \\ 0 & 1 \end{smallmatrix}\right]$ and three linear functions of 1, m, n, nm, will contain as a factor the topical resultant of 1, m, n, mn.

Nor must it be supposed that Involutants are the only species of invariants in the modified sense first described which appertain to the system m and n. Thus *ex. gr.* when $\omega = 2$ it is not only true that the determinant of the matrix $mn - nm$ is such a kind of Invariant (which for greater clearness it may be desirable to denote by the term Perpetuitant†), but each element of that matrix will also be a perpetutant, and these 4 perpetutants, when for m, n $\rho m, \phi n$ are substituted, will be in an invariable ratio to one another and to either square root of the Involutant.

In like manner it will eventually be seen that for two matrices m, n of any order ω, it is possible to form a matrix of the order ω analogous to $mn - nm$ (which be it observed may be regarded as the Determinant of the matrix $\begin{smallmatrix} m & n \\ m & n \end{smallmatrix}$) each of whose ω^2 terms will be in a constant ratio to each other and to any ωth root of I and of J.

I will now return to the problem of finding what is the form of the equation which connects the ω^2 matrices denoted by $(1, m, m^2, \ldots m^{\omega-1})$ $(1, n, n^2, \ldots n^{\omega-1})$ when such an equation admits of being formed, *i. e.* $I = 0$.

To fix the ideas let us suppose that m, n are matrices of the 3d order of perfectly general form so that the m, n involution necessitates the satisfaction of one single condition, $I = 0$.

Let $A + Bn + Cn^2 = 0$ be the equation whose form is to be determined where A, B, C, are each of them quadratic functions of m. I say that neither A, B, nor C, can contain a non-vacuous linear factor. For suppose that any one of them as A should contain the non-vacuous factor $m + q$, and that $A = (m + q)(am + p)$.

Then we may multiply the equation by $(m + q)^{-1}$ and thus obtain the equation $(am + p) + B'n + C'n^2 = 0$, *i. e.* we have an equation in which not all 9 but only 8 of the terms signified by $(1, m, m^2)(1, n, n^2) = 0$ are linearly related. But this obviously implies, contrary to the hypothesis, the existence of two equations of condition instead of one.

Hence then A, must be of the form $c(m - \lambda)(m - \lambda')$ where λ, λ' are each of them a latent root of m; whether the same or different remains to be determined.

In like manner it may be shown that B is of the form $c_1(m - \lambda_1)(m - \lambda_1')$ and C of the form $c_2(n - \lambda_2)(m - \lambda_2')$. But now I say further that $(m - \lambda)(m - \lambda')$, $(m - \lambda_1)(m - \lambda_1')$, $(m - \lambda_2)(m - \lambda_2')$ must be identical.

For 1° suppose that any one pair of the λ's, say λ, λ', are distinct. If any other pair, say λ_2, λ_2', is not identical with this pair on multiplying the equation by $m - \lambda''$ where λ'' is the 3d latent root of M, the term containing the term $A(\lambda - \lambda'')$ will vanish, but $B(\lambda - \lambda'')$ will not vanish and consequently there will be an equation if $C(\lambda - \lambda'')$ does not vanish between 6 only and if $C(\lambda - \lambda'')$ does vanish between 3 only of the 9 terms denoted by $(1, m, m^2)(1, n, n^2)$ contrary to hypothesis.

The only remaining supposition is that A, B, C are each perfect squares. Suppose, then, that any one of them as A is a multiple of $(m - \lambda)^2$, unless B, C are each of them also multiples of the same on multiplying the equation by $(m - \lambda')(m - \lambda'')$, one of the three coefficients of $1, n, n^2$ will vanish but one at least of the other two will not vanish, which is impossible for the same reason as before. Hence the left-hand side of the equation of involution must contain $(m - \lambda)(m - \lambda')$ as a sinister factor where λ, λ' (whether the same or different) are latent roots of λ. And in like manner precisely, by arranging the equation of involution under the form $A' + mB' + m^2C'$ where A', B', C' are quadratic functions of n, it may be found that the same function must contain $(n - \mu)(n - \mu')$ where μ, μ' are latent roots of n as a dexter factor.

Hence the form of the equation must be

$$(m - \lambda)(m - \lambda')(n - \mu)(n - \mu') = 0.$$

It is easy to see that we cannot have λ and λ' the same latent root of m and at the same time μ, μ' the same latent root of n, for then the above product would have at almost the nullity 2 whereas it is an absolute null, *i. e.* has the nullity 3.

But I will now show that λ, λ' and μ, μ' must each consist of unlike roots. Let t be any term of the matrix $(m - \lambda)(m - \lambda')(n - \mu)(n - \mu')$ where t will be a known function of the elements of m, n, of λ, λ' entering symmetrically, and of μ, μ' also entering symmetrically: this is the same thing as saying that t will be a function of the elements of m and n, of λ'', μ'', and of the coefficients of the equations which contain the 3 latent roots of λ and μ respectively.

Consequently the product of the 9 values of t found by writing λ'', λ', λ for λ'', and μ'', μ', μ for μ'' will be a rational integer function of the elements of m, n which vanishes when the Involutant I vanishes and must consequently contain I as a factor. If then, *in any single instance*, the matrix $(m - \lambda)^2(n - \mu')(n - \mu'')$ does not vanish for some one value of λ and μ when I vanishes, it cannot be the form [or *one of two* conceivably possible coexisting forms] of the left hand side of the general equation of involution. A similar remark of course applies to

$$(m - \lambda_1)(m - \lambda_2)(n - \mu_1)^2.$$

Let now $m = \begin{smallmatrix} 1 & 0 & 0 \\ 0 & \rho & 0 \\ 0 & 0 & \rho^2 \end{smallmatrix}$, $n = \begin{smallmatrix} 0 & \rho & k \\ k & 0 & \rho^2 \\ 1 & k & 0 \end{smallmatrix}$.

The latent roots of m are 1, ρ, ρ^2, and of n are θ, $\rho\theta$, $\rho^2\theta$, where $\theta = \sqrt[3]{1 + k^3}$; we have also

$$m^2 = \begin{smallmatrix} 1 & 0 & 0 \\ 0 & \rho^2 & 0 \\ 0 & 0 & \rho \end{smallmatrix}, \qquad n^2 = \begin{smallmatrix} -\rho^2 k & k^2 & 1 \\ \rho^2 & -k & k^2 \\ k^2 & \rho & -\rho k \end{smallmatrix}.$$

The three values of $(m - \lambda')(m - \lambda'')$ are

$$\begin{smallmatrix} 3 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{smallmatrix}, \quad \begin{smallmatrix} 0 & 0 & 0 \\ 0 & 3\rho^2 & 0 \\ \theta & 0 & 3\rho \end{smallmatrix}, \quad \begin{smallmatrix} 0 & 0 & 0 \\ 0 & 3\rho & 0 \\ 0 & 0 & 3\rho^2 \end{smallmatrix},$$

and the three values of $(n - \mu_1)(n - \mu_2)$ are

$$\begin{vmatrix} -\rho^2 k + \theta^2 & k^2 + \rho\theta & 1 + \theta k \\ \rho^2 + \theta k & -k + \theta^2 & k^2 + \rho^2\theta \\ k^2 + \theta & \rho + \theta k & -\rho k + \theta^2 \end{vmatrix} \begin{vmatrix} -\rho^2 k + \rho^2\theta^2 & k^2 + \rho^2\theta & 1 + \rho\theta k \\ \rho^2 + \rho\theta k & -k + \rho^2\theta^2 & k^2 + \theta \\ k^2 + \rho\theta & \rho + \rho\theta k & -\rho k + \rho^2\theta^2 \end{vmatrix}$$

$$\begin{vmatrix} -\rho^2 k + \rho^2\theta & k^2 + \theta & 1 + \rho^2\theta k \\ \rho^2 + \rho^2\theta k & -k + \rho\theta^2 & k^2 + \rho\theta \\ k^2 + \rho^2\theta & \rho + \rho^2\theta k & -\rho k + \rho\theta^2 \end{vmatrix}.$$

The general value of $(m - \lambda_1)(m - \lambda_2)(n - \mu_1)(n - \mu_2)$ will (to a numerical factor *près*) be a matrix consisting of a single column accompanied by two columns of zeros, the non-zero column being some one of the 9 columns found in the above 3 matrices.

Now by direct calculation we know that the m, n Involutant in this case is a numerical multiple of $(k^3 - \rho^3)^3$ and vanishes when $k^3 = \rho^3$, which gives $\theta = \sqrt[3]{1 + \rho^3}$, *i. e.* $-\rho = \theta^3$ and if we please $k = \theta^2$.

Hence not merely one but three of the products of $(m - \lambda')(m - \lambda'')$ $(n - \mu')(n - \mu'')$ will in this case vanish, for the above equations will cause the 2d, 4th and 9th columns all to become columns of nulls.

* I for some time had imagined, and indeed thought I had proved, that the two involutants were always identical. When crossing the Atlantic last month on board the Arizona, having hit upon a pair of matrices of the third order, for which the two topical resultants admitted of easy calculation, I found, to my surprise, that they were perfectly distinct. The cause of the failure of the supposed proof constitutes a paradox which will form the subject of a communication to a future meeting of the Johns Hopkins Mathematical Society.

I will here only promise that the seeming contradiction between the logical conclusion and the facts of the case takes its rise in a sort of mirage with which invariantists are familiar, viz.: the apparent *à priori* establishment of algebraical forms as the result of perfectly valid processes, which forms have no more real existence in nature than the Corona of the Sun under our Dr. Hastings' scrutinizing gaze: the contradiction between the logical inference and the truth being accounted for by the circumstance that any such supposed form on actual performance of the operations indicated, turns out to be a congeries of terms, each affected with a null coefficient; we are thus taught the lesson that all *à priori* reasoning until submitted to the test of experience, is liable to be fallacious, and it is impossible to prove that a proof may not be erroneous by any other method than that of actual trial of the results which it is supposed to yield.

† *Perpetuitant* formed from *perpetuity* by analogy to Annuitant from Annuity. Perpetuant would have been better, but that it has already been applied by myself in the theory of Invariants in a sense recognized and adopted by Cayley, Hammond, and MacMahon.

If now instead of the factor $(m-\lambda')(m-\lambda'')$ we substitute the factor $(m-\lambda)^2$, the three values of $(m-\lambda)^2$ will become

$$\begin{matrix} 0 & 0 & 0 \\ 0 & -3\rho & 0 \\ 0 & 0 & -3\rho^2 \end{matrix} \qquad \begin{matrix} -3 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -3\rho^2 \end{matrix} \qquad \begin{matrix} -3 & 0 & 0 \\ 0 & -3\rho & 0 \\ 0 & 0 & 0 \end{matrix}$$

so that if $(m-\lambda)^2(n-\mu')(n-\mu'')$ is to vanish, it will readily be seen that each of two columns of one or the other of the two matrices representing $(n-\mu')(n-\mu'')$ will have to vanish simultaneously, and that this cannot be brought to pass when $\theta^3=-\rho$ and $k^3=\rho^3=\theta^6$ whether we make $k=\theta^2$ or $-\theta^5$ or θ^8.

Hence $(m-\lambda)^2(n-\mu')(n-\mu'')=0$ is not an admissible general involution form of equation. Similarly by interchanging the above special values assigned to m and n, it may be shown that $(m-\lambda')(m-\lambda'')(n-\mu)^2=0$ is not an admissible form, and consequently that the one universal form of the involution equation is expressed by saying that $(m-\lambda')(m-\lambda'')(n-\mu')(n-\mu'')$ is an absolute null. If no connexion exists between the elements of m and n, we know from the law of nullity that the above matrix has a nullity 2, *i. e.* that all its minors except the elements themselves have zero contents. The effect of the vanishing of I is to make the elements themselves one and all vanish when the two sets of latent roots are duly selected.

So in general if $F=\lambda^\omega-A_1\lambda^{\omega-1}+A_2\lambda^{\omega-2}-A_3\lambda^{\omega-3}\ldots=0$,
and $G=\mu^\omega-B_1\mu^{\omega-1}+B_2\mu^{\omega-2}-B_3\mu^{\omega-3}\ldots=0$,
are the two equations to the latent roots of m, n matrices of order ω, and if

$$M=m^{\omega-1}-(A_1-\lambda)m^{\omega-2}+(A_2-A_1\lambda+\lambda^2)m^{\omega-3}\ldots$$

and $$N=n^{\omega-1}-(B_1-\mu)n^{\omega-2}+(B_2-B_1\lambda+\lambda^2)n^{\omega-3}\ldots$$

$MN=0$ for some value of λ and of μ is the one equation of involution, and $NM=0$ for some value of λ and some value of μ is the other such equation.

I will now show how to deduce from the above statement the following marvellous theorem.

Let H represent the sum of the product of each term in the matrix M by its *altruistic opposite* in N (so that H is a function of λ and μ and of degree $\omega-1$ in each of them) then will the ordinary Algebraical Resultant of F, G, H* be exactly equal (in magnitude as well as form) to the product of the two involutants to the *corpus* m, n.†

(To be continued in the following number of the Circular.)

* The system of equations whose resultant expresses the undifferentiated condition of involution, may be written under the form $(x, y)^\omega=0$; $(x, t)^\omega=0$; $(x,y)^{\omega-1}=0$. *Quære* whether such a resultant may not be writ under the form of a determinant by an application of the Dialytic Method?

† If I and J be the two involutants $I=0$ will be the condition of left-handed involution of m, n or right-handed of n, m and $J=0$ of right-handed involution of m, n or left-handed of m, m, for Involution, like light, "has sides." But $IJ=0$ will be the condition of *one* or *the other* kind, or so to say of undifferentiated Involution.

On Quadruple Theta-Functions, by T. Craig.

[Abstract of a paper in the *American Journal of Mathematics*, Vol. VI, No. 1].

This paper is intended simply as an introduction to the theory of theta-functions of four variables. The method of investigation is that used by Prof. Cayley in his well-known memoir on the single and double theta-functions. In the first part of the paper the formulae connected with the decomposition of a characteristic into the sum of two others are given, and the two known equations arrived at, viz.,

$$\vartheta\begin{pmatrix}a+2x\\ \beta+2y\end{pmatrix}(u)=(-)^{\Sigma\beta y}\vartheta\begin{pmatrix}a\\ \beta\end{pmatrix}u,$$

$$\vartheta\begin{pmatrix}a\\ \beta\end{pmatrix}(-u)=(-)^{\Sigma a\beta}\vartheta\begin{pmatrix}a\\ \beta\end{pmatrix}(u),$$

$\vartheta\begin{pmatrix}a\\ \beta\end{pmatrix}(u)$ being written for brevity to denote

$$\vartheta\begin{pmatrix}a_1a_2a_3a_4\\ \beta_1\beta_2\beta_3\beta_4\end{pmatrix}(u_1,u_2,u_3,u_4).$$

The second deals with the true and quasi periods, and contains a symmetrically arranged table of the even and odd functions. The product theorem is then given in the form

$$\vartheta\begin{pmatrix}a\\ \beta\end{pmatrix}(u+u')\vartheta\begin{pmatrix}a'\\ \beta'\end{pmatrix}(u-u')=$$

$$\Sigma\Theta\begin{pmatrix}\frac{1}{2}(a+a')+p\\ \beta+\beta'\end{pmatrix}(2u)\Theta\begin{pmatrix}\frac{1}{2}(a-a')+p\\ \beta-\beta'\end{pmatrix}(2u').$$

Θ is written to denote that the coefficients a_{ik} in the exponent of ϑ are replaced here by $2a_{ik}$. There are sixteen terms in the sum corresponding to

$$p\equiv p_1,p_2,p_3,p_4=0,1.$$

The 256 square-products are given in sixteen tables, a square-product meaning such a product as

$$\vartheta\begin{pmatrix}a\\ \beta\end{pmatrix}(u+u')\vartheta\begin{pmatrix}a\\ \beta\end{pmatrix}(u-u'),$$

i. e., where both factors have the same characteristic. Sixteen more tables are given for the determination of the relations among the zero values of the even functions. The present paper will be at once followed by Part II dealing with the linear relations connecting the squares of the quadruple theta-functions.

NOTES IN PHILOSOPHY.

The Philosophical Conception of Life, by G. S. Morris.

[Abstract of a paper read before the University Metaphysical Club, October 9, 1883].

The writer first briefly substantiated the view that all attempted explanations of life in terms of what is conceived as "mere matter" and motion, or of mere "force," have always been and must ever remain fruitless, so far as it is a question of recognizing and demonstrating the characteristic and essential nature of life itself, and not simply the laws of certain of its sensible manifestations. Matter, motion, and force presuppose life; or, life is their logical and ontological *prius*, and is not, therefore, to be conceived as their mechanical product.

It was then argued (1) that all life is an activity. (2) This activity has in every case a definite and specific character, law, or direction. It is typical, or conforms to a specific type, which is to it as its *idée directrice*. (3) The activity of life is thus teleological. The type, by which it is defined, is realized in and through the activity; it is the "end," in which the activity is completed. (4) The activity in question is thus also ideally determined, at least in form; and, what is more important to notice, the *form* of any, even the lowest, process of life is one of self-determination, or of self-realization; the type, the law, the idea, has the air of giving to itself its own concrete realization. It is this appearance of spontaneous, independent, and ideally directed activity, that gives to nature its true poetic charm for human intelligence; and it is indeed this, also, that renders nature, in the exact and complete sense of the expression, an intelligible object for man. (5) To the *form* of *self*-realization the proper corresponding *substance* is self-conscious will, or will permeated by, and organically one with, conscious intelligence. This, of which the life of nature, as above characterized, must be held to be prophetic, is found in man, who, in his character as a consciously self-determining and self-realizing spirit, is to be viewed as illustrating in greater fulness and completeness than any other created being known to man, the true and concrete nature of life. In all life that which truly lives and is, is something ideal, some truth—in the lower grades some law, idea, or type—working itself out into reality, and sustaining itself therein, by an apparently independent and self-directed, active process. In man this "something ideal," this truth, has consciousness of itself, and its independence and self-direction subsist, or are to subsist, not only in form, but also in substance and in full reality.

Attention was then called to the fact that the truth, of which the higher life of men is to be the expression and (in its measure) the realization, is not merely single and particular, like the "idea" of the tree, or of the human body. It is not simply *some* truth, *some* ideal, but *the* truth, *the*

ideal, universally, that in some way and essential measure he must realize or actively share in, in order that he may lead the truer life of the spirit. Its centre is therefore not in the individual, but outside of him; and it realizes and manifests itself, first of all, as an organizing principle of society—in family, in civil relations, in the state, and in the great movement of history—in and through which the spiritual personality of the individual lives and thrives, and separated from which, he would run the risk of speedy decay. But in none of these shapes does the truth manifest itself in an absolutely independent life. This life it must be held to lead in God, as Absolute Spirit, in whom, accordingly, all the dependent life of nature—but especially the self-conscious life of the human spirit—finds its true centre; so that the perfect life of man is to know God, as the living Truth, and, by doing his will, ("walking in the truth,") to share in his life.

CURRENT INFORMATION.

Resignation of Professor Sylvester.

It will be seen from the following official action, that Professor Sylvester has asked leave to resign his Professorship of Mathematics in the Johns Hopkins University, and has been elected *Professor Emeritus*. He has returned from Europe and will continue to discharge the duties of his chair until the beginning of next year.

ACTION OF THE TRUSTEES.

"At a meeting of the Trustees of the Johns Hopkins University, held October 1, 1883, a letter from Professor Sylvester to President Gilman, dated London, September 12, 1883, was read to the Board, containing his resignation of the Professorship of Mathematics in the Johns Hopkins University, to take effect on the first day of January next, and expressing the unfailing and deep interest which he feels in the continued well doing of the University.

"Whereupon it was

"*Resolved*, That as this resignation is doubtless the result of mature reflection on the part of Professor Sylvester, it is hereby accepted, but that in doing so the Board of Trustees cordially extend to him its hearty thanks for the invaluable services which he has rendered to the University, and also its profound sense of the great ability, the conscientious fidelity and untiring energy with which he has discharged the arduous duties of his chair, thereby elevating the science of Mathematics to its proper plane, not only in this institution but in this country.

"It was also *Resolved*, That Professor Sylvester be and he is hereby appointed Professor Emeritus in the Johns Hopkins University."

The American School at Athens.

Professor Gildersleeve has declined the appointment to be Director of the American School at Athens, which was made by the Committee without consulting him.

Correspondence.

Extract from a letter to PROFESSOR SYLVESTER *by* PROFESSOR CAYLEY.

"... Would it surprise you to learn that the number of sextic perpetuants for any weight w whatever is $= 0$? I get this out (subject to one weak point in my demonstration), viz., in the equation

$$\{6\} + \{4.2\} + \{3.3\} + \{2.2.2\} = \frac{x^6}{2.3.4.5.6} + S,$$

(your theory as corrected by Hammond), I find $S = \frac{x^6 + x^{12} - 2x^{16} - x^{18}}{2.3.4.5.6}$,

which, with the known values of $\{4.2\}$, $\{3.3\}$ and $\{2.2.2\}$ gives $\{6\} = 0$. And if no sextic perpetuant—then *I presume* (but have not considered this) no perpetuant of any higher degree.

It seems to me there is no *à priori* objection to this result. Consider for an equation of an indefinite order, the symmetrical functions, represented in the usual manner by a partition-symbol $1 = \Sigma a$, $11 = \Sigma a\beta$, $2 = \Sigma a^2$, &c., then any symmetrical function whatever = Rational and integral function of 1, 11, 111, &c.

In the seminvariant theory, instead of any partition-symbols whatever, we have the non-unitary symbols, 2, 22, &c., 3, 32, 33, &c., . . . and the theorem would be: Any non-unitary symmetrical function = Rational and integral function of 2, 22, 222, 3, 33, &c., 5, 54, &c,, with no figure exceeding 5.

Curious if true—but why not? . . ."

Peabody Institute Lectures.

A general course of thirty lectures will be given in Peabody Hall, every Tuesday and Thursday evening at 8 o'clock, from November 6 to February 28, with a recess of two weeks at Christmas.

[Reprinted from the Peabody Institute Calendar for 1883–4.]

I. REV. JOHN C. ECCLESTON, D. D., of Staten Island. Four illustrated lectures, Nov. 6, 8, 13, 15, on *The Crusades.*

1. The First Crusade, from the march of Peter the Hermit in 1096 till the investment of Jerusalem in 1099; 2. The Second and Third Crusades, from the capture of Jerusalem in 1099 till its re-capture by Saladin in 1187; 3. The Third and Fourth Crusades, from the departure of Richard Cœur de Lion in 1189 till the capture of Constantinople in 1204; 4. Fifth, Sixth, Seventh, and Eighth Crusades, from the invasion of Egypt in 1218 till the fall of Acre in 1291.

These lectures will be illustrated by a large number of lantern views taken from "Gustave Doré's magnificent illustrations of Michaud's Crusades.

II. DR. H. NEWELL MARTIN, of Johns Hopkins University. Four illustrated lectures, Nov. 20, 22, 27, 29, on *The Minds of Animals.*

1. Instinct and Reason; 2. The minds of Social insects—ants, bees, and wasps; 3. Reason and Instinct in the higher animals; 4. Emotions and the moral sense in animals.

III. MR. WM. I. MARSHALL, of Fitchburg, Mass., but for ten years a resident of the Rocky Mountain region, visiting the parks, living among the miners as one of them, and travelling through the mountains from British America to the Yosemite Valley. Six illustrated lectures, Dec. 4, 6, 11, 13, 18, 20, on *The Wonders of the Rocky Mountains.*

1 and 2. The Yellowstone National Park; 3 and 4. Gold mines and Gold mining; 5. The Yosemite Valley and the Big Trees; 6. Colorado.

These lectures will be illustrated by numerous lantern projections taken from the object represented.

IV. PROF. EDWARD S. MORSE, of Salem, Mass., for several years a resident of Japan and a professor in the University of Tokio. Six illustrated lectures Jan. 8, 10, 15, 17, 22, 24, on *Life in Japan.*

1. Japanese Homes and their Surroundings; 2. Temples, Theatres, Music; 3. City Life and Health Matters; 4. Educational Matters and Students; 5. Keramic and Pictorial Art; 6. Antiquities.

These lectures will be illustrated by free hand drawings on the blackboard and by lantern views.

V. MR. LOCKE RICHARDSON, of New Jersey. Four lectures with recitals, Jan. 29, 31, Feb. 5, 7, on *Shakspere's Plays.*

1. Macbeth; 2. Julius Cæsar; 3. Twelfth Night; 4. King Lear.

Mr. Richardson presents a condensed version of each play, reciting the principal scenes, which he connects together by a thread of narrative, and elucidates by explanatory and critical remarks.

VI. PROF. S. P. LANGLEY, of Allegheny Observatory. Six illustrated lectures, Feb. 12, 14, 19, 21, 26, 28, on *The Sun and Stars.*

1. Size and Distance of the Sun; 2. The Solar Surface; 3. Solar Heat; 4, Solar Light 5. Eclipses; 6. The Stars.

These lectures will be thoroughly illustrated by stereopticon views representing the telescopic appearances of the Sun and Stars.

NOTES ON RECENT PUBLICATIONS

BY MEMBERS OF THIS UNIVERSITY.

BROOKS, W. K. The Law of Heredity. A Study of the Cause of Variation, and the Origin of Living Organisms. (*Baltimore: J. Murphy & Co. 348 pp., 12mo. $2.00*).

The aim of this book is to disentangle from our stores of recorded facts, a clew to the nature and causes of Heredity; that is, the nature and causes of the power of each organism to produce offspring which are essentially like itself, while they also exhibit those slight differences which lead, as they have led in the past, to the endless diversity of living things and to the more and more perfect adaptation of each organism to the world around it.

According to accepted authorities, all the characteristics of a species are transmitted by each parent, and the ovum and male cell are alike in function. The author shows that there is no proof of this view, while he gives many reasons for holding its opposite, and for believing that the two reproductive elements play very different parts in heredity. Among other proofs he instances the fact that when two species or varieties are crossed reciprocally, the offspring of the male of A and the female of B is usually quite different from the offspring of the female of A with the male of B; and also the fact that while a male cell has never been observed to develop without union with an egg, the development of unfertilized eggs into perfect animals, both male and female, is not at all unusual, since certain animals have been reared through many generations of fertile females, without the presence of a single male.

The evidence furnished by the study of variation, of hybrids, of the secondary sexual characters of animals, and of the intellectual differences between men and women, is examined, at some length, in order to discover the nature of the difference in the functions of the reproductive elements, and as the result of this examination the author concludes that the established hereditary characteristics of the species are transmitted by the ovum, while new variations are due to the influence of the male element. He holds that the female factor is conservative and the male progressive.

Among the many facts presented in proof of this are the following: the offspring of a male hybrid and a female of either pure parent form is more variable than the offspring of a female hybrid with the male of either parent form; in reciprocal hybrids the recently acquired characteristics of the species used as the father predominate; variation is extremely rare in organisms produced asexually, so rare that there is an obvious connection, although it is not an absolute one, between variation and sexual reproduction; an organ which is confined to males is more variable than one confined to females; an organ which is excessively developed in males alone, or one which is peculiarly useful to males, is more variable than one which is excessively developed or most useful in females; the males of allied species or varieties differ more than the females; the mature male differs more than the mature female from the young; males are more variable than females; and so forth.

Having given proof of the existence of divergent specialization in the functions of the reproductive elements, the author attempts to trace the way in which this specialization has originated, and he is led to the conclusion that natural selection has so acted as to evolve a secondary law, the law of heredity, and that, in all the higher organisms the modification of species is, at present, chiefly due to the direct action of this law, and only indirectly to natural selection.

Briefly stated the law of heredity is this: The ovum has, by direct inheritance from the ovum of the preceding generation, power to transmit all the established hereditary characteristics of the race; Each cell of the body of a many-celled organism has the power to form cell-germs or gemmules, but this power is not exercised so long as a cell is in harmony with its environment; When a change in any cell is needed, this cell throws off gemmules which are stored up in the male reproductive element, and are thus transmitted to the fertilized ovum; Their union with the ovum, or conjugation, causes variation in the corresponding cells of the offspring; The ovarian ova derived from the fertilized ovum inherit the same tendency, and a new hereditary congenital variation is thus presented for the action of natural selection.

In the concluding chapters, the author points out that our conception of the action of natural selection is greatly simplified by the recognition of the law of heredity, and that the acceptance of the latter law does away with most of the objections which have been urged against the law of natural selection.

ADAMS, H. B. Village Communities of Cape Anne and Salem. Reprinted from the Historical Collections of the Essex Institute. (*Nos. 9 and 10 of the "Studies in Historical and Political Science." 81 pp., 8°*).

This monograph on the oldest village-republic of the Massachusetts Colony comprises six minor Studies, which have appeared in separate form during the past two years in the Historical Collections of the Essex Institute. The first of these Studies, "The Fisher Plantation at Cape Anne," was reported in the *University Circular*, *No.* 12, *December*, 1881. The second Study on "The Origin of Salem Plantation," shows the evolution of this Town from the Cape Anne germ. The so-called Old Planters, who in 1626 removed from the region of "Fishermen Fields" in the present Town of Gloucester to the "pleasant and fruitful neck of land" called Naumkeag by the Indians, were the first settlers of Salem. The Indian clearing, the open Mark, was the basis of the new Village Community. There, as one of the first settlers testified, "the English and the Indians had a feild in comon fenced in together."

The third paper, on the "Allotments of Land in Salem to Men, Women, and Maids," treats of the distribution of house and land lots for tillage. The house lots were usually small, varying from a quarter of an acre to an acre. The normal amount of planting land allotted to an individual was ten acres. It was ordered that the least family should have ten acres, but greater families, more, according to the number of persons in the household. Widows received their individual share of ten acres, with ten more for every son. "Maids lotts" were at first granted, but it was finally determined to avoid "all presedents & evil events of graunting lotts vnto single maidens not disposed of in marriage."

The paper on "Common Fields in Salem" describes the reproduction of the old English system of associate tillage. Individual owners of planting lands fenced in common and determined by a majority vote how they should plant and when they should harvest the common field. There were no less than ten such common fields in Salem as early as 1640. Old North Fields and South Fields are still spoken of by ancient inhabitants. The original manuscript records of the South Field Proprietary were found in Salem by the author of this paper and have been utilized for illustrating old agrarian customs. The article on "Salem Meadows, Woodland, and Town Neck" demonstrates that the meadows, or grass lands, were originally, as in New Plymouth, absolutely common to the Town; and when they were finally allotted to the inhabitants, the meadows were "proportioned out vnto them according to the heads of their families." Woodland was also originally held in absolute commonage. As in Plymouth, no timber, wood, or boards could be sold or transported out of Town. The Town Neck was a stinted Town Pasture, near the Village, "for milch cows and riding horses." Such a pasture in old England is termed a *Ham*. The Town Neck continued to be used as a Home pasture by the Town of Salem down to the time of the present generation, and it is still used as an open-air nursery for Salem children, for the Town Neck has been converted into a public pleasure-ground, with booths and merry-go-rounds. Salem once had village shepherds, herdsmen, swineherds like Gurth and Eumaeus, town flocks, town herds, and even town dogs for hunting wolves.

The sixth paper on "The Great Pastures" treats of a remarkable case of agrarian survival from the original pastoral domain of the Town of Salem. There are to this day within Salem limits some three hundred acres of common land called the Great Pastures, and owned by the heirs or descendants of the original settlers. This tract is the last remnant of the great "Range," once embracing about four thousand acres and extending over the towns of Peabody and Danvers. The history of the

gradual break-up of this *ager publicus* or folk-land of Salem is traced in detail. It is shown that precisely the same agrarian questions which agitated the plebeians and patricians of Rome once disturbed the cottagers and commoners of this little village-republic of Salem. The cottagers were new comers and landless men; the commoners were the descendants of old comers and were proprietors of the commons. The village-patricians yielded gradually to the demands of the *plebs*, but the struggle was long and bitter. The witch trials, which occurred only a few years before the passage of Salem's agrarian laws, were of far less consequence in New England history than this slow moving, economic revolution which resulted in the break-up of land-community and the establishment of freehold land tenure for all classes. In studying the town records of Salem and Plymouth, one cannot fail to perceive that the undercurrent of New England town-life, however broken the surface, is one steady and unceasing drift of hard common sense, driven on by the resistless pressure of cumulating majorities and by the grinding force of public necessity.

MORRIS, G. S. Philosophy and Christianity. A Series of Lectures, delivered in New York [and repeated at the Johns Hopkins University], in 1883, on the Ely Foundation of the Union Theological Seminary. (*New York: Carter & Brothers. 329 pp., 12mo. $1.75.*)

Religion and philosophy are held to be, or to involve, simply two different functions of one and the same intelligence, and with reference to the same objects of intelligence. "A religion," says Dr. Frantz Schultze (*Philosophie der Naturwissenschaft*, Leipzig, 1882, *Bd.* II, p. 418), "is a conception of the world, which has assumed the character of a universal popular philosophy (*Volksphilosophie*)." Or religion, on its intellectual side, is, at least in form and ideal, the immediate apprehension and assertion of final truths, which philosophy seeks reflectively to comprehend and to demonstrate. In particular, the thesis is reached and laid down, at the end of Lecture I, that "Philosophy and Christianity alike imply (1) a process of intelligence (Theory of Knowledge), by which (2) the absolute object of intelligence is reached (Theory or Science of Being)."

The attempt is then made to show—on the basis of a preliminary, summary statement of the "Philosophic Theory of Knowledge" and of the "Philosophic Theory of Reality" (Lectures II and III), and through a special examination of the "Biblical theory of Knowledge" (Lecture IV), and of "Biblical Ontology" with reference to God (Lecture V), the World (VI), and Man (VII)—that the fundamental ideal content of Christianity is "philosophic" (VIII), or that Christianity is "absolute religion."

LANIER, SIDNEY. The English Novel and the Principle of its Development. (*New York: Charles Scribner's Sons. 299 pp., 12mo. $2.00.*)

This is a reproduction, in book form, of a course of public lectures delivered in the Johns Hopkins University in the winter and spring of 1881.

The leading line of thought is the continual development of the principle of personality, and its great expansion in modern times. That is to say, on the side of science, the personality of the individual is now minutely studied, instead of being kept in abeyance or disregarded altogether; and on the side of art, the artist, instead of following types, infuses more and more of personality—his own or another's—into his work. Although the movement in this direction has been continuous, yet the latter half of the seventeenth century may be conveniently taken as an epoch in its development, by the appearance of Bach, Newton, and Richardson, who may be regarded as the founders of modern music, modern science, and the modern novel.

Taking the novel, a story of life and character, as his more immediate theme, the author illustrates the grand impersonal Greek mode of treatment from the *Prometheus* of Aeschylus, where the actors are vast dim types of great powers or abstractions, and the interest centres in colossal action and suffering; then notes in passing the gradual increase of personality in later poets and prose writers, until its highest development is reached in the works of George Eliot, where portraiture is carried to the last refinement, and the individual, with his personal joys and sorrows, trials, failures, or triumphs, is everything.

ROWLAND, H. A. A Plea for Pure Science. (Address as Vice President of the Section of Physics of the American Association for the Advancement of Science, Minneapolis, August 15, 1883.)

This address is published in full in *Science*, August 24, 1883, also in the *Journal of the Franklin Institute*, *Nature*, the *Popular Science Monthly*, etc.

ELY, RICHARD T. French and German Socialism in Modern Times. (*New York: Harper & Brothers. 274 pp. 16mo. 75 cents.*)

The aim of this work, as stated in the preface, is to give "a perfectly fair, impartial presentation of modern communism and socialism in their two strongholds, France and Germany." It was not at all the intention of the author to offer a critique of the various socialistic theories which he has sketched, inasmuch as economic literature abounds in refutations of communism and socialism. Newspapers and magazines circulate in every part of the country, which make continual warfare on all radical social reformers, but it is not so evident that they understand the men whom they combat. The service which the author hoped to render to society was to expose the strength of its opponents, and this he believed it dangerous to underrate.

This book offers a series of sketches of the lives and doctrines of French and German communists and socialists from 1789 up to the present. Events are brought down to August, 1883.

The topics treated of are the following: The French Revolution and the Laboring Classes, Baboeuf, Cabet, Saint Simon, Fourier, Louis Blanc, Proudhon, Socialism in France since Proudhon, Rodbertus, Karl Marx, The International Workingmen's Association, Ferdinand Lassalle, The Ideal of Social Democracy, Social Democracy since the Death of Lassalle, Socialism of the Chair, Christian Socialism.

MARTIN, H. N. The Human Body. An Elementary Text-Book of Anatomy, Physiology, and Hygiene. (*New York: Henry Holt & Co. 355 pp. 8. $1.50.*)

"This elementary text-book of Physiology has been prepared in response to many requests for a text-book framed on the same plan as the "Human Body," but abridged for the use of students younger, or having less time to give to the subject, than those for whom that book was designed.

As a department of science, modern Physiology is controlled mainly by two leading generalizations—the doctrine of the "Conservation of Energy" and that of the "Physiological division of labor." I have endeavored in this, as in the larger book, to keep prominent these leading principles; and, so far as is possible in an elementary book, to exhibit the ascertained facts of Physiology as illustrations of or deductions from them.

Apart from the attempt to make elementary Physiology a more useful educational instrument than it has frequently hitherto been, the present volume differs from most others of its grade in having, as foot-notes or as appendices to the chapters, simple practical directions, assisting a teacher to demonstrate to his class certain fundamental things. The practical directions are, for the most part, reprints from a series of such which I drew up some years ago for a class composed of Baltimore teachers; those experiments which required costly apparatus have, of course, been omitted. The interest which my "Teacher's Class" took in its work, and the good use its members subsequently made of it, have encouraged me to believe that others might be glad of a few hints as to things suitable to show to young students of Physiology."—*Extract from Preface.*

PEABODY INSTITUTE. Catalogue of the Library of the Peabody Institute of the City of Baltimore, part I, A–C. (*Baltimore, 1883, 868 pp., 8°*).

Notice deferred.

HOPKINS HALL LECTURES.

Notice in Respect to the Admission of the Public.

In answer to inquiries, and in correction of some current misapprehensions, the following statements are made in respect to these courses of lectures annually given in the Johns Hopkins University.

1. These courses are academic lectures, designed primarily for the members of the University, and supplementary to the regular class-room work of the students.
2. As the members of the University rarely require the entire room, the Trustees have taken great pleasure in inviting other persons, not connected with the University, to attend.
3. As these lectures are not intended for popular entertainment, but for the instruction of students, those persons first receive tickets, in most cases, who are known to be especially interested in a particular course,—ladies as well as gentlemen. Preference is thus given according to the character of the course, to teachers in other institutions, public and private; students of medicine, law, etc.; professional men and others. If any tickets remain undistributed, they are given out to those who may have applied for them, in order of application.
4. The hall is full when 200 hearers are present; it is uncomfortable if more are admitted. Not infrequently two or three times that number of persons apply for admission, and often applications for tickets cannot be granted. To give the lectures elsewhere would alter their character as a part of the ordinary academic work of the University.
5. *There is no general course ticket issued.* Applications should state specifically the course for which tickets are desired. Programmes and other current information pertinent to university work may be found in the *University Circulars*, sent to subscribers on the payment of one dollar per annum, either by Messrs. Cushings & Bailey, Messrs. John Murphy & Co., or the University.

   The usage of giving personal notification is not likely to be continued, and those therefore who have been accustomed to receiving such announcements, should hereafter consult the *Circulars*.
6. It will save much delay if applications for tickets and inquiries on these and other routine matters are addressed not to individuals but to the JOHNS HOPKINS UNIVERSITY, *by postal card*, and answers will be promptly returned by mail. Personal applications consume time needlessly.

☞ **The lectures begin at 5 o'clock *punctually*. The doors of the hall are opened at fifteen minutes before 5, and the lectures do not exceed an hour in the delivery.**

PROGRAMME OF LECTURES, SESSION 1883-84.

I. HISTORY AND POLITICAL SCIENCE.

DR. H. VON HOLST, Professor in the University of Freiburg. Ten lectures, October 8–16.

The special subjects considered were the Relation of History and Politics, or of historical study and political speculations, with illustrations from the History and Politics of European States.

II. FRENCH LITERATURE.

M. RABILLON, Lecturer on French Literature, will give a course of seven lectures (*in French*) on *The Chanson de Roland*, beginning Thursday, November 1, and continuing on successive Thursdays, at 4 *p. m.*, till December 13.

The following topics will be considered:—

I. Introduction. How the early Romance of France was a source of poetry for the nations of Europe until the Renaissance;—II. History of the Chanson de Roland;—III. The Treason of Ganelon;—IV. Roland's death;—V. The defeat of the French;—VI. The revenge;—VII. The punishment of the traitor, and conclusion.

III. MUNICIPAL HYGIENE.

DR. JOHN S. BILLINGS, (Surgeon, United States Army), will give a course of twelve lectures on *Municipal Hygiene*, beginning Monday, November 5, and continuing on successive *Mondays and Wednesdays*, as follows:

1. Monday, November 5.—The growth of cities and their importance in modern civilization. Death rate in cities; Comparisons. The significance of death rates.
2. Wednesday, November 7.—The mortality rates of Baltimore. Life table for Baltimore. Mortality in different wards. Causes of disease.
3. Monday, November 12.—Causes of disease, continued. The Germ-theory and some of its applications.
4. Wednesday, November 14.—Water-supply; impure water; water analysis; filtration; waste of water.
5. Monday, November 19.—Disposal of refuse, garbage, etc. Disposal of excreta. Cesspools; dry conservancy; sewerage.
6. Wednesday, November 21.—Systems of sewerage so-called; separate system; Waring system; Liernur system, etc.
7. Monday, November 26.—House drainage and plumbing as connected with municipal regulations.
8. Wednesday, November 28.—Streets, parks, and cemeteries.
9. Monday, December 3.—Schools and education.
10. Wednesday, December 5.—Food, markets, etc.
11. Monday, December 10.—Jurisprudence of hygiene; Management of contagious diseases; quarantine.
12. Wednesday, December 12.—Health Departments and Health Officers; duties and responsibilities; private sanitary organizations. Conclusion.

These lectures are designed first for students of the university, next for persons officially or for other reasons interested in sanitary science and the administration of cities, and then for the medical profession. The number of these persons is so large that the invitation cannot be extended to others.

IV. ROMAN LEGAL HISTORY.

JAMES BRYCE, Esq., M. P., D. C. L., Regius Professor of the Civil Law in the University of Oxford, will give a short course of lectures, *Introductory to the Study of Roman Legal History*, in Hopkins Hall, beginning Tuesday, November 20, at 5 p. m.

On account of the large number of students who are expected to attend this course it is not possible to extend a general invitation to the public.

V. CLASSICAL ARCHÆOLOGY.

MR. JOSEPH THACHER CLARKE, who has been in charge of the work of the Archæological Institute of America at Assos, will give three lectures on *Classical Archæology*, as follows:

1. Tuesday, December 11.—The rise of Archæology since the death of Winckelmann to its present position as a science.
2. Friday, December 14.—The results of the recent investigations at Assos, with particular reference to the unpublished work of the last two years.
3. Tuesday, December 18—Cyrene, and the Colonies of the Greeks in Northern Africa: the advantages presented by the Cyrenaica as a field for archæological researches.

Particulars in regard to the following courses will be given later.

The Fertilization of Flowers. PROFESSOR WILLIAM TRELEASE, of the University of Wisconsin. Four lectures, in January.

English Literature. PROFESSOR HIRAM CORSON, of Cornell University. Twenty lectures, January 21 to March 7.

LIST OF OFFICERS AND STUDENTS, 1883-84.

(Preliminary list of names and residences. The Annual Register of the University, containing the full list of names, etc., is published at the close of the academic year).

TRUSTEES.

PRESIDENT.	TREASURER.	SECRETARY.
GEORGE W. DOBBIN.	FRANCIS WHITE.	LEWIS N. HOPKINS.

GEORGE WILLIAM BROWN, 89 W. Chase St.
GEORGE W. DOBBIN, St. Denis P. O., Baltimore Co.
JOSEPH P. ELLIOTT, 187 St. Paul St.
JOHN W. GARRETT, 77 W. Monument St.
CHARLES J. M. GWINN, 35 Mt. Vernon Place.
LEWIS N. HOPKINS, 138 St. Paul St.
FRANCIS T. KING, 76 Cathedral St.
J. HALL PLEASANTS, 66 Mt. Vernon Place.
ALAN P. SMITH, 45 Franklin St.
C. MORTON STEWART, 167 Dolphin St.
JAMES CAREY THOMAS, 317 Madison Av.
FRANCIS WHITE, 237 St. Paul St.

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ACADEMIC STAFF.

DANIEL C. GILMAN, LL.D., *President of the University.* 81 Saratoga St.

A. B., Yale College, 1852, and A. M., 1855; LL. D., Harvard University and St. John's College, 1876; Professor in Yale College, 1863-72; President of the University of California, 1872-75.

BASIL L. GILDERSLEEVE, PH.D., LL.D., *Professor of Greek.* 253 St. Paul St.

A. B., Princeton College, 1849, and A. M., 1852; Ph. D., University of Göttingen, 1853; LL. D., College of William and Mary, 1869; Professor of Greek in the University of Virginia, 1856-76; Professor of Latin in the University of Virginia, 1861-66; *Editor of the American Journal of Philology.*

PAUL HAUPT, PH.D., *Professor of the Shemitic Languages.* 163 St. Paul St.

Ph. D., University of Leipsic 1878; Professor of Assyriology in the University of Göttingen.

H. NEWELL MARTIN, DR.SC., A.M., *Professor of Biology, and Director of the Biological Laboratory.* 221 St. Paul St.

M. B., University of London, 1871, and Dr. Sc., 1872; A. B., University of Cambridge, 1874, and A. M., 1877; late Fellow and Lecturer on Natural History in Christ College, Cambridge; Fellow of University College, London; M. D. (Hon.), University of Georgia, 1881; *Editor of Studies from the Biological Laboratory.*

CHARLES D. MORRIS, A.M., *Collegiate Professor of Latin and Greek.* 158 N. Howard St.

A. B., Lincoln College, Oxford, 1849, A. M., and Fellow of Oriel College, Oxford, 1852; Professor in the University of New York, 1875-76.

IRA REMSEN, M.D., PH.D., *Professor of Chemistry, and Director of the Chemical Laboratory.* 218 St. Paul St.

College of the City of New York; M. D., College of Physicians and Surgeons, N. Y., 1867; Ph. D., University of Göttingen, 1870; Professor of Chemistry in Williams College, 1872-76, and previously Assistant in Chemistry in the University of Tübingen; *Editor of the American Chemical Journal.*

HENRY A. ROWLAND, PH.D., *Professor of Physics, and Director of the Physical Laboratory.* 14 Cathedral St.

C. E., Rensselaer Polytechnic Institute, Troy, 1870; Assistant Professor in the same, 1872-75; Ph. D., Johns Hopkins University, 1880.

J. J. SYLVESTER F.R.S., D.C.L., *Professor of Mathematics.* St. James Hotel.

A. M., University of Cambridge; F. R. S., London and Edinburgh; Corresponding Member, Institute of France; Member, Academy of Sciences in Berlin, Göttingen, Naples, Milan, St. Petersburg, etc.; LL. D., University of Dublin, University of Edinburgh; D. C. L., University of Oxford; Honorary Fellow of St. John's College, Cambridge; late Professor of Mathematics in the Royal Military Academy, Woolwich; Copley Medalist, Royal Society, London, 1880; *Editor of the American Journal of Mathematics.*

JOHN S. BILLINGS, M. D., *Lecturer on Municipal Hygiene.*

A B., Oxford (Ohio), 1857, and A. M., 1860; M. D., Cincinnati, 1860; Surgeon, U. S. Army, and Librarian of the Surgeon General's Office.

HIRAM CORSON, A.M., LL.D., *Lecturer on English Literature.*

Professor of Anglo-Saxon and English Literature in the Cornell University.

G. STANLEY HALL, PH.D., *Lecturer on Psychology.*

A.B., Williams College, 1867, and A.M., 1870; Ph.D., Harvard University, 1878; Lecturer in Harvard and Williams Colleges;

J. RENDEL HARRIS, A.M., *Lecturer on New Testament Greek.* Mosher and McCulloh Sts.

A. B., University of Cambridge, 1874, and A. M., 1877; Fellow, and late Lecturer and Librarian of Clare College, Cambridge.

H. VON HOLST, PH. D., *Lecturer on History.*

Professor in the University of Freiburg, Germany.

GEORGE S. MORRIS, A.M., PH. D., *Lecturer on the History of Philosophy.* 132 W. Madison St.

A. B., Dartmouth College, 1861, and A. M., 1864; Ph. D., University of Michigan, 1881; Professor of Logic, Ethics, and the History of Philosophy in the University of Michigan.

CHARLES S. PEIRCE, A.M., S.B., *Lecturer on Logic.* 272 N. Calvert St.

A. B., Harvard University, 1859, A. M., and S. B., 1863; of the U. S. Coast and Geodetic Survey.

LÉONCE RABILLON, BACH. ÈS LETT., *Lecturer on French Literature.* 69 Park Av.

Bach. ès Lettres, Université de France, 1832, and Licencié en Droit, 1836.

CHARLES F. RADDATZ, *Examiner in German.* 228 Argyle Av.

Professor in the Baltimore City College.

HERBERT B. ADAMS, PH. D., *Associate Professor of History.* 41 Cathedral St.

A. B., Amherst College, 1872; Ph. D., University of Heidelberg, 1876; *Editor of University Studies in Historical and Political Science.*

MAURICE BLOOMFIELD, PH.D., *Associate Professor of Sanskrit.* 128 W. Madison St.

A. M., Furman University, 1877; Ph. D., Johns Hopkins University, 1879.

WILLIAM K. BROOKS, PH. D., *Associate Professor of Morphology and Director of the Chesapeake Zoölogical Laboratory.* 75 Mt. Royal Av.

A. B., Williams College, 1870; Ph. D., Harvard University, 1875.

THOMAS CRAIG, PH. D., *Associate Professor of Applied Mathematics.* 12 First St.

C. E., Lafayette College, 1875; Ph. D., Johns Hopkins University, 1878.

CHARLES S. HASTINGS, PH. D., *Associate Professor of Physics, Sub-Director of the Physical Laboratory, and Lecturer on Solar Physics.* 8 Denmead St.

Ph. B., Yale College, 1870, and Ph. D., 1873; Holder of the "Tyndall Scholarship" in Paris, 1875.

HARMON N. MORSE, PH. D., *Associate Professor of Chemistry and Sub-Director of the Chemical Laboratory.* 266 N. Howard St.

A. B., Amherst College, 1873; Ph. D., University of Göttingen, 1875; Instructor in Chemistry at Amherst College, 1875-76.

WILLIAM E. STORY, PH. D., *Associate Professor of Mathematics.* 256 N. Calvert St.

A. B., Harvard University, 1871; Ph. D., University of Leipsic, 1875; Tutor of Mathematics at Harvard University, 1875-76.

MINTON WARREN, PH. D., *Associate Professor of Latin.* 84 W. Monument St.

A. B., Tufts College, 1870; Ph. D., University of Strassburg, 1879.

WILLIAM HAND BROWNE, M.D., *Librarian, and Examiner in English.* 2 Huntingdon Av.

M. D., University of Maryland, 1850.

A. MARSHALL ELLIOTT, A. M., *Associate in Romance Languages.* 241 N. Calvert St.

A. B., Haverford College, 1866, and A. M., 1873; A. B., Harvard University, 1868.

RICHARD T. ELY, PH. D., *Associate in Political Economy.* 288 Madison Av.

A. B., Columbia College, 1876, and A M., 1879; Fellow of Columbia College, 1876-79; Ph. D., University of Heidelberg, 1879.

FABIAN FRANKLIN, PH. D., *Associate in Mathematics.* 258 Linden Av.

Ph. B., Columbian University, 1869; Ph. D., Johns Hopkins University, 1880.

J. FRANKLIN JAMESON, PH. D., *Associate in History.* 54 McCulloh St.

A. B., Amherst College, 1879; Ph. D., Johns Hopkins University, 1882.

PHILIP R. UHLER, *Associate in Natural History.* 218 W. Hoffman St.

Librarian of the Peabody Institute, and President of the Maryland Academy of Sciences.

GEORGE H. WILLIAMS, PH. D., *Associate in Mineralogy.* 43 Cathedral St.
A. B., Amherst College, 1878; Ph. D., University of Heidelberg, 1882.

HENRY WOOD, PH. D., *Associate in English.* 67 Oak St.
A. B., Haverford College, 1869; Ph. D., University of Leipsic, 1879.

G. THEODORE DIPPOLD, PH. D., *Instructor in German.* 134 W. Madison St.
Ph. D., Boston University, 1883.

EDWARD M. HARTWELL, M. D., PH. D., *Instructor in Physical Culture.* 87 Park Av.
A. B., Amherst College, 1873, and A. M., 1876; Ph. D., Johns Hopkins University, 1881; M. D., Miami Medical College, 1882.

HUGH NEWELL, *Instructor in Drawing.* 58 Lexington St.

CHARLES L. WOODWORTH, JR., *Instructor in Elocution.* 680 Madison Av.
Amherst College; Boston University School of Oratory, 1875.

HERBERT W. CONN, A. B., *Assistant in Biology.* 125 Park Av.
A. B., Boston University, 1881.

H. H. DONALDSON, A. B., *Assistant in Biology.* 143 St. Paul St.
A. B., Yale College, 1879.

OTTO LUGGER, *Assistant in Biology.* 429 N. Carey St.

HARRY F. REID, A. B., *Assistant in Physics.* 75 Mt. Vernon Place.
A. B., Johns Hopkins University, 1880.

EDWARD H. SPIEKER, PH. D., *Assistant in Greek and Latin.* 123 N. Paca St.
A. B., Johns Hopkins University, 1879, and Ph. D., 1882.

HENRY A. TODD, A. B., *Assistant in Romance Languages.* The Brexton.
A. B., Princeton College, 1876, Fellow and Tutor in Modern Languages in Princeton College, 1876-80.

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STUDENTS.

FELLOWS BY COURTESY.

R. DORSEY COALE. Baltimore. 215 *Madison Av.*
Ph. D., Johns Hopkins University, 1881; Fellow in this University, 1880-81, and Assistant in the Chemical Laboratory, 1881-83; Lecturer on Chemistry in the University of Maryland. *Chemistry.*

WILLIAM P. DURFEE, Berkeley, Cal. 28 *McCulloh St.*
A. B., University of Michigan, 1876; Ph. D., Johns Hopkins University, 1883; Fellow of this University, 1881-83. *Mathematics.*

ADOLPH GERBER. Germany. 28 *McCulloh St.*
Ph. D., University of Munich, 1882. *Teutonic Languages.*

HENRY R. GOODNOW. Brooklyn, N. Y. 209 *N. Howard St.*
A. B., Amherst College, 1878; Fellow of this University, 1882-83. *Physics.*

ARTHUR L. KIMBALL. Plainfield, N. J. 186 *St. Paul St.*
A. B., Princeton College, 1881; Fellow in Science, Princeton College, 1881-2; Fellow of this University, 1882-83. *Physics.*

THOMAS W. MILLS. Montreal, Quebec. 164 *N. Eutaw St.*
A. B., University of Toronto, 1871, and A. M., 1873; M. D., McGill University, 1878; L. R. C. P. (Eng.); Demonstrator of Physiology and Histology at McGill University. *Biology.*

HENRY L. OSBORN. Madison, N. J. 266 *N. Howard St.*
A. B., Wesleyan University, 1878; Fellow of this University, 1881-82. *Biology.*

HENRY N. STOKES. Moorestown, N. J. 24 *McCulloh St.*
S. B., Haverford College, 1878; Fellow of this University, 1881-83. *Chemistry.*

HENRY A. SHORT. New York City. (A)
A. B., Columbia College, 1880; Fellow of Columbia College, 1880-83. *Greek.*

WILLIAM C. THAYER. Geneva, N. Y. (A)
A. B., Columbia College, 1876; Professor in Hobart College, 1882-83. *Latin, etc.*

ALBERT L. WEBSTER. Staten Island, N. Y. 87 *Park Av.*
Ph. B., Yale College, 1879; Topographer of U. S. Geological Survey, 1880-83. *Biology and Chemistry.*

EDMUND B. WILSON. Geneva, Ill. (A)
Ph. B., Yale College, 1878; Ph. D., Johns Hopkins University, 1881; Fellow in this University, 1879-81; now studying in the Marine Laboratory at Naples under Dr. Dohrn. *Biology.*

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(A). Not now in attendance on the University.

FELLOWS.

WILLIAM M. ARNOLT. New Brunswick, N. J. 213 *W. Biddle St.*
Stuttgart Gymnasium, 1878; B. D., New Brunswick Theological Seminary, 1882. *Greek.*

GUSTAV BISSING. Baltimore. 264 *W. Lombard St.*
A. B., Johns Hopkins University, 1882. *Mathematics.*

ADAM T. BRUCE. New York City. 123 *W. Madison St.*
A. B., Princeton College, 1881. *Biology.*

ARCHIBALD L. DANIELS. Kendallville, Ind. 118 *W. Biddle St.*
A. B., University of Michigan, 1876. *Mathematics.*

ELLERY W. DAVIS. Baltimore. 28 *McCulloh St.*
S. B., University of Wisconsin, 1879. *Mathematics.*

DAVID T. DAY. Baltimore. 266 *N. Howard St.*
A. B., Johns Hopkins University, 1881. *Chemistry.*

JOHN DEWEY. Burlington, Vt. 266 *N. Howard St.*
A. B., University of Vermont, 1879. *Philosophy.*

JAMES R. DUGGAN. Macon, Ga. 330 *N. Eutaw St.*
A. B., Mercer University, 1877, and A. M., 1880; M. D., Jefferson Medical College, 1879. *Chemistry.*

ALFRED EMERSON. Baltimore. 218 *N. Carrollton Av.*
Ph. D., University of Munich, 1881. *Greek.*

ARTHUR L. FROTHINGHAM. Rome, Italy. 132 *W. Madison St.*
Ph. D., University of Leipsic, 1883. *Shemitic Languages.*

ELGIN R. L. GOULD. Oshawa, Ont. 52 *McCulloh St.*
A. B., Victoria University, 1881. *History.*

ARTHUR S. HATHAWAY. Decatur, Mich. 205 *N. Howard St.*
S. B., Cornell University, 1879. *Mathematics.*

WILLIAM H. HOWELL. Baltimore. 433 *N. Mount St.*
A. B., Johns Hopkins University, 1881. *Biology.*

HANS C. G. VON JAGEMANN. Naumburg, Germany. 209 *W. Biddle St.*
Naumburg Gymnasium, 1876. *Modern Languages.*

EDWARD H. KEISER. Allentown, Pa. 266 *N. Howard St.*
S. B., Swarthmore College, 1880, and S. M., 1881. *Chemistry.*

GUSTAV A. LIEBIG, JR. Baltimore. 307 *St. Paul St.*
A. B., Johns Hopkins University, 1882. *Physics.*

C. W. EMIL MILLER. Baltimore. 306 *S. Sharp St.*
A. B., Johns Hopkins University, 1882. *Greek.*

CHARLES A. PERKINS. Ware, Mass. 8 *McCulloh St.*
A. B., Williams College, 1879. *Physics.*

LEWIS T. STEVENS. Baltimore. 121 *Charles St. Av.*
A. B., Johns Hopkins University, 1882. *Biology.*

LEWIS W. WILHELM. Baltimore. 11 *Edmondson Av.*
A. B., Johns Hopkins University, 1880. *History.*

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GRADUATE STUDENTS.

JOHN J. ABEL. Cleveland, Ohio. 110 *Edmondson Av.*
Ph. B., University of Michigan, 1883. *Biology and Chemistry.*

CYRUS ADLER. Philadelphia, Pa. 852 *Linden Av.*
A. B., University of Pennsylvania, 1883. *Shemitic Languages.*

EDMUND K. ALDEN. Marshfield, Mass. 82 *Bolton St.*
A. B., Amherst College, 1880. *English, History, etc.*

ETHAN A. ANDREWS. New York City. 182 *Madison Av.*
Ph. B., Yale College, 1881. *Biology.*

WILLIAM W. BADEN. Baltimore. 51 *W. Fayette St.*
A. B., Johns Hopkins University, 1881. *Latin and Greek.*

WILLIAM S. BAYLEY. Baltimore. 641 *W. Lombard St.*
A. B., Johns Hopkins University, 1883. *Chemistry and Mineralogy.*

EDWARD W. BEMIS. Springfield, Mass. 40 *McCulloh St.*
A. B., Amherst College, 1880. *History.*

T. ALEXIS BERRY. Baltimore. 247 *Bolton St.*
A. B., Johns Hopkins University, 1882. *History and Political Science.*

HENRY G. BEYER. U. S. N. *The Albion.*
M. D., Bellevue Hospital Medical College, 1876; M. R. C. S. (Eng.); Passed Assistant Surgeon, U. S. N. *Biology.*

BENJAMIN L. BOWEN. Chili Station, N. Y. 48 *McCulloh St.*
A. B., University of Rochester, 1881. *Modern Languages.*

WILLIAM S. BOYD, JR. Kingstree, S. C. 120 *N. Green St.*
A. B., Davidson College, 1882. *Chemistry and Biology.*

RICHARD N. BRACKETT. Charleston, S. C. 266 *N. Howard St.*
A. B., Davidson College, 1882. *Chemistry.*

PAUL McD. BRICE. Winnsboro, S. C. 266 *N. Howard St.*
A. B., Erskine College, 1883. *English and Political Science.*

JAMES D. BRUCE Charlotte Co., Va. 55 *Saratoga St.*
A. M., University of Virginia, 1883. *Chemistry.*

RICHARD E. BURTON. Hartford, Conn. 132 *W. Madison St.*
A. B., Trinity College, 1883. *English.*

J. TEVIS COBB. Richmond, Ky. 54 *McCulloh St.*
A. B., Central University (Ky.), 1879, and A. M., 1883. *Modern Languages.*

ALFRED D. CROWE. Baltimore. 115 *W. Townsend St.*
A. B., Geneva College, 1874. *Languages.*

DAVIS R. DEWEY. Burlington, Vt. 266 *N. Howard St.*
A. B., University of Vermont, 1879. *History and Political Science.*

THOMAS H. DINSMORE. York, Pa. *York, Pa.*
A. B., Highland University (Kansas), 1876, A. M., 1879, and Ph. D., 1883. *Chemistry, etc.*

THOMAS DIXON, JR. Shelby, N. C. 111 *Charles St. Av.*
A. M., Wake Forest College, 1883. *History and Political Science.*

CHARLES S. DOLLEY. Rochester, N. Y. 40 *McCulloh St.*
M. D., University of Pennsylvania, 1882. *Biology.*

FRANK DONALDSON, JR. Baltimore. 108 *Park Av.*
A. B., Harvard University, 1879; M. D., University of Maryland, 1883. *Biology.*

LOUIS DUNCAN. Baltimore. 10 *N. Carey St.*
U. S. Naval Academy, 1880. *Physics and Mathematics.*

CHARLES G. DUNLAP. Chillicothe, Ohio. 36 *Boundary Av.*
A. B., Ohio Wesleyan University, 1883. *English.*

ALBERT E. EGGE. Decorah, Iowa. 150 *N. Eutaw St.*
A. B., Norwegian Luther College, 1879. *English, German, etc.*

JULIAN O. ELLINGER. Baltimore. 410 *Park Av.*
U. S. Naval Academy, 1883. *Physics and Mathematics.*

HERBERT C. ELMER. Rushford, N. Y. 16 *McCulloh St.*
A. B., Cornell University, 1883. *Latin and Greek.*

WILLIAM H. EMERSON. Tunnel Hill, Ga. 218 *Linden Av.*
U. S. Naval Academy, 1880. *Chemistry and Physics.*

GUSTAV A. EVENSON. Iola, Wis. 150 *N. Eutaw St.*
A. B., Norwegian Luther College, 1880. *Teutonic Languages.*

JULIUS I. FAERBER. Dorpat, Russia. 48 *McCulloh St.*
University of Dorpat, Russia. *Mathematics.*

JOHN A. FISHER. Baltimore. 48 *W. Monument St.*
Ph. B., Illinois Wesleyan University, 1880. *History and Philosophy.*

JOSEPH A. FONTAINE. Bué, France. 187 *N. Eutaw St.*
College of Nancy, France, 1879. *Romance Languages.*

ANDREW FOSSUM. Elon, Iowa. 150 *N. Eutaw St.*
A. B., Norwegian Luther College, 1882. *Greek and History.*

LOUIS GARTHE. Baltimore. 98 *Hill St.*
A. B., Johns Hopkins University, 1882. *Modern Languages.*

WILLIAM S. GRAVES. Liberty, Va. 265 *Linden Av.*
A. M., Washington and Lee University, 1869, and B. L., 1872. *Greek and Latin.*

GEORGE B. HALDEMAN. Cedarville, Ill. 16 *McCulloh St.*
A. B., Beloit College, 1883. *Biology.*

CLAYTON C. HALL. Baltimore. 142 *Park Av.*
Physics and Mathematics.

ALBERT A. HANNA. Baltimore. 231 *Maryland Av.*
M. D., University of Maryland, 1875. *Biology.*

HOMER W. HILLYER. Waupun, Wis. 262 *W. Hoffman St.*
S. B., University of Wisconsin, 1882. *Chemistry.*

WILLIAM P. HOLCOMB. Newtown, Pa. 266 *N. Howard St.*
B. L., Swarthmore College, 1878, and M. L., 1881. *History and Political Science.*

ANDREW HOLSTAD. Decorah, Iowa. 172 *W. Biddle St.*
A. B., Norwegian Luther College, 1881. *Greek and Latin.*

EDWIN C. HOWELL. Asbury Park, N. J. *The Brexton.*
A. B., Harvard College, 1883. *Mathematics.*

ABEL H. HUIZINGA. Zeeland, Mich. 213 *W. Biddle St.*
A. B., Hope College, 1880, and A. M., 1883. *Greek and Sanskrit.*

EDWARD INGLE. Baltimore. 358 *Linden Av.*
A. B., Johns Hopkins University, 1882. *History.*

JOSEPH JASTROW. Philadelphia, Pa. 256 *W. Lombard St.*
A. B., University of Pennsylvania, 1882. *Philosophy and Logic.*

HORACE F. JAYNE. Philadelphia, Pa. *St. James Hotel.*
A. B., University of Pennsylvania, 1879, and M. D., 1882. *Biology.*

GEORGE T. KEMP. Baltimore. 55 *N. Green St.*
A. B., Johns Hopkins University, 1883. *Biology.*

JOHN H. KENNARD, JR. New Orleans, La. 125 *Park Av.*
University of Louisiana, 1883. *History and Political Science.*

FREDERIC S. LEE. Canton, N. Y. 266 *N. Howard St.*
A. B., St. Lawrence University (N.Y.), 1878, and A. M., 1881. *Biology.*

F. F. CARL LEHMANN. Hamburg, Germany. 266 *N. Howard St.*
LL. D., University of Göttingen, 1883. *Shemitic Languages.*

CHARLES H. LEVERMORE. New Haven, Conn. 263 *N. Howard St.*
A. B., Yale College, 1879. *History and Political Science.*

GONZALES LODGE. Baltimore. 445 *N. Mount St.*
A. B., Johns Hopkins University, 1883. *Greek and Latin.*

CHARLES T. McCLINTOCK. Millersburg, Ky. 330 *N. Eutaw St.*
A. B., Kentucky Wesleyan College, 1851. *Biology and Chemistry.*

IRWIN P. McCURDY. Frederick. *Frederick.*
B. E., Indiana (Pa.) State Normal School, 1876, and M. E., 1878; A. B., Lafayette College, 1880. *English.*

WILLIAM R. McDANIEL. St. Michaels. 38 *Mulberry St.*
A. B., Western Maryland College, 1880. *Mathematics, etc.*

JOSEPH S. MILLER. York, Pa. 143 *Mulberry St.*
M. D., College of Physicians and Surgeons (Balto.), 1880. *Biology and Chemistry.*

PARK MORRILL. Loudon, N. H. 47 *Courtland St.*
A. B., Amherst College, 1881; U. S. Signal Service. *Physics.*

HENRY F. NACHTRIEB. St. Paul, Minn. 210 *Hoffman St.*
S. B., University of Minnesota, 1882. *Biology.*

JULIUS NELSON. Waupaca, Wis. 225 *Druid Hill Av.*
S. B., University of Wisconsin, 1881. *Biology.*

HENRY B. NEWSON. Mt. Gilead, Ohio. 266 *N. Howard St.*
S. B., Ohio Wesleyan University, 1883. *Chemistry and Physics.*

HENRY B. NIXON. Winfall, N. C. 28 *McCulloh St.*
University of North Carolina, 1876. *Mathematics and Physics.*

WILLIAM H. OSBORNE. Asheville, N. C. 142 *N. Charles St.*
A. M., Wake Forest College, 1883. *Greek and Latin.*

JOSEPH T. OUTEN. Millersburg, Ky. 266 *N. Howard St.*
A. B., Ohio Wesleyan University, 1867, and A. M., 1870. *Mathematics and Physics.*

JAMES PAGE. Baltimore. 81 *W. John St.*
A. B., Johns Hopkins University, 1882. *Physics.*

ALBERT G. PALMER. Baltimore. 172 *McCulloh St.*
A. B., Johns Hopkins University, 1883. *Chemistry.*

ERNEST M. PEASE. Boulder, Colo. 226 *Druid Hill Av.*
A. B., University of Colorado, 1883. *Latin.*

MANSFIELD T. PEED. Petersburg, Va. 156 *N. Schroeder St.*
A. M., Randolph Macon College, 1878. *Physics and Mathematics.*

CAMERON PIGGOT. Baltimore. 90 *N. Fulton St.*
M. D., University of Maryland, 1883. *Chemistry.*

ROBERT J. PRATT. Albany, N. Y. 132 *W. Madison St.*
C. E., Rensselaer Polytechnic Institute, 1883. *Physics.*

B. JAMES RAMAGE. Newberry, S. C. 52 *McCulloh St.*
A. B., Newberry College, 1880. *History.*

DANIEL R. RANDALL. Annapolis. 365 *N. Charles St.*
A. B., St. John's College, 1883. *History and Political Science.*

EDSON P. RICH. Brownville, Neb. 1 *McCulloh St.*
B. L., University of Nebraska, 1883. *History and Political Science.*

PERLEE L. RIEMAN. Baltimore. 101 *W. Monument St.*
A. B., Princeton College, 1883. *Chemistry, Physics and Mathematics.*

LAWRASON RIGGS, JR. Baltimore. 82 *Cathedral St.*
A. B., Princeton College, 1883. *History and Political Science.*

ADONIRAM J. ROBINSON. Baltimore. 192 *Mulberry St.*
A. B., Johns Hopkins University, 1881. *Philosophy.*

EDWARD B. SANGER. Rockville Centre, N.Y. 184 *N. Charles St.*
Geology and Chemistry.

SHOSUKI SATO. Sapporo, Japan. 54 *McCulloh St.*
Sapporo Agricultural College (Japan), 1880. *History and Political Economy.*

WALTER B. SCAIFE. Pittsburgh, Pa. 140 *Cathedral St.*
LL. B., University of Michigan, 1880. *History, etc.*

EDWARD M. SCHAEFFER. Baltimore. 328 *Lexington St.*
M. D., University of Maryland, 1880. *Chemistry.*

LOUIS H. SCHUBART. New York City. 178 *W. Lombard St.*
S. B., College of the City of New York, 1882. *Chemistry and Physics.*

SHADRACH SIMPSON. Westminster. *Westminster.*
A. B., Trinity College (N. C), 1873, and A. M., 1875; Professor in Western Maryland College. *Chemistry.*

ALBERT SHAW. Grinnell, Ia. 71 McCulloh St.
A. B., Iowa College, 1879, and A. M., 1882. *History and Political Science.*

MOSES SLAUGHTER. Brooklyn, Ind. 226 *Druid Hill Av.*
A. B., Indiana Asbury University, 1883. *Latin and Greek.*

EVERT B. SMEDES. Raleigh, N. C. 142 *N. Charles St.*
A. B., University of North Carolina, 1883. *Chemistry.*

PRESTON STAMPS. Milton, N. C. 142 *N. Charles St.*
Ph. B., University of North Carolina, 1883. *Chemistry.*

WILLIAM B. STEEL. Port Deposit. 258 *Linden Av.*
A. B., Lafayette College, 1879, and A. M., 1882. *History and Political Science.*

JAMES E. STOUT. Baltimore. 121 *Mulberry St.*
University of Virginia, 1869. *Latin and Greek.*

HENRY TABER. New York City. 190 *N. Calvert St.*
Ph. B., Yale College, 1882. *Logic, etc.*

BOND V. THOMAS. Baltimore. 317 *Madison Av.*
A. B., Haverford College, 1883. *History and Political Science.*

ALBERT H. TOLMAN. Pittsfield, Mass. 8 *McCulloh St.*
A. B., Williams College, 1877. *English.*

CHARLES D. WALLER. Selma, Ala. 266 *N. Howard St.*
A. B., Erskine College, 1883. *English and Political Science.*

CLARENCE D. WARNER. Granby, Mass. 57 *Bolton St.*
S. B., Mass. Agricultural College, 1881. *Mathematics and Physics.*

FREDERICK M. WARREN, Durham, Maine. 82 *Bolton St.*
A. B., Amherst College, 1880. *Romance Philology and History.*

HENRY C. WARREN. Boston, Mass. 132 *W. Madison St.*
A. B, Harvard University, 1879. *Sanskrit.*

HENRY V. WILSON. Baltimore. 314 *Linden Av.*
A. B., Johns Hopkins University, 1883. *Biology.*

WOODROW WILSON. Wilmington, N. C. 146 N. Charles St.
A. B., Princeton College, 1879, and A. M., 1882. *History and Political Science.*

THOMAS K. WORTHINGTON. Baltimore. 209 *N. Howard St.*
A. B., Haverford College, 1883. *History and Political Science.*

CHARLES B. WRIGHT. Akron, O. 8 *McCulloh St.*
A. B., Buchtel College, (Ohio), 1880. *English.*

ARTHUR YAGER. Georgetown, Ky. 268 *N. Howard St.*
A. B., Georgetown College, (Ky.), 1879. *History and Political Science.*

GLOSSBRENNER V. YONCE. Lutherville. *Lutherville.*
A. B., Roanoke College, 1877, and A. M., 1882. *Chemistry.*

JOHN H. ZWEIZIG. Reading, Pa. 162 *Franklin St.*
A. B., Muhlenberg College, 1882. *Greek.*

(101)

Members of the Historical Seminary.

In addition to 27 elsewhere enrolled.

EDGAR GOODMAN. Baltimore. 314 *Hollins St.*
A. B., Johns Hopkins University, 1880; LL. B., University of Maryland, 1881.

EDWIN HEBDEN. Baltimore. 377 *N. Bond St.*
Dickinson College.

JOHN JOHNSON. Baltimore County. *McDonogh P. O.*
A. B., Johns Hopkins University, 1881.

JOHN C. ROSE. Baltimore. 187 *N. Fremont St.*
LL. B., University of Maryland, 1883.

BASIL SOLLERS. Baltimore. 279 *Mosher St.*
Baltimore City College, 1871.

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Members of the Chesapeake Zoölogical Laboratory.

SESSION OF 1883.

W. BATESON. Cambridge, Eng.
St. John's College, University of Cambridge, Eng.

HERBERT W. CONN. Fitchburg, Mass.
A. B., Boston University, 1881.

J. E. EARLE. New York City.

OLIVER P. JENKINS. Moore's Hill, Ind.
A. B., Moore's Hill College, 1869, and A. M., 1872.

FREDERIC S. LEE. Canton, N. Y.
Enrolled above.

J. PLAYFAIR MCMURRICH. Toronto, Ont.
Assistant in Biology, University of Toronto.

THOMAS W. MILLS. Montreal, Quebec.
Enrolled above.

HENRY F. NACHTRIEB. St. Paul, Minn.
Enrolled above.

HENRY L. OSBORN. Madison, N. J.
Enrolled above.

J. H. PILLSBURY. Springfield, Mass.
Professor of Natural Science, Springfield, Mass.

HENRY SEWALL. Ann Arbor, Mich.
Ph. D., Johns Hopkins University, 1879; Professor of Physiology, University of Michigan.

WILLIAM E. STRATTON. Baltimore.
A. B., Johns Hopkins University, 1883.

ALBERT H. TUTTLE. Columbus, O.
S. B., Pennsylvania State College, 1868; Professor of Zoölogy at Ohio State University.

HENRY V. WILSON. Baltimore.
Enrolled above.

FRANCIS WINSLOW. U. S. N.
Lieut. U. S. N.; U. S. Fish Commission.

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MATRICULATES.

JOSEPH S. AMES. Faribault, Minn. 215 *Druid Hill Av.*
Shattuck School.

ALBERT C. APPLEGARTH. Baltimore. 632 *W. Fayette St.*
Baltimore City College.

C. WALTER ARTZ. Hagerstown. 73 *Edmondson Av.*
Mr. J. T. Carlile, Instructor.

RICHARD H. BAYARD. Baltimore. 41 *Cathedral St.*
Mr. W. S. Marston's School.

THOMAS H. BUCKLER, Baltimore. 135 *N. Charles St.*
Harvard College.

JOHN P. CAMPBELL. Charlestown, W. Va. 352 *N. Eutaw St.*
Andrew Small Academy.

WALTER B. CANFIELD. Baltimore. 43 *Cathedral St.*
Mr. G. G. Carey's School.

GEORGE G. CAREY, JR. Baltimore. 265 *N. Eutaw St.*
Mr. G. G. Carey's School.

WILLIAM K. CROMWELL. Baltimore County. 94 *W. Lombard St.*
Mr. H. W. Luckett, Instructor.

CHARLES W. R. CRUM. Jefferson. 263 *N. Eutaw St.*
Franklin and Marshall College.

EUGENE L. CRUTCHFIELD,* Baltimore. (A)
Mr. S. Z. Ammen, Instructor.

WILLIAM R. DEWITT.* Baltimore County. *McDonogh P. O.*
McDonogh School.

ALFRED R. L. DOHME.* Baltimore. 27 *Hollins St.*
Friends' High School.

WILLIAM S. EICHELBERGER.* Woodberry. *Woodberry.*
Baltimore City College, 1883.

HARRY ENGLISH.* Washington, D. C. *Washington, D. C.*
Washington High School.

GEORGE B. FADELEY.* Baltimore. 443 *W. Fayette St.*
Mr. W. S. Marston's School.

JAMES C. FIFIELD.* Kearney, Neb. 358 *N. Eutaw St.*
Phillips (Andover) Academy.

HARRY FRIEDENWALD. Baltimore. 88 *N. Eutaw St.*
Baltimore City College.

WILLIAM E. GATES.* Philadelphia, Pa. 79 *McCulloh St.*
Mr. George Eastburn, Instructor.

PHILIP C. GILBERT.* Glencoe. *Glencoe.*
Mr. G. G. Carey's School.

JOHN GLENN, JR. Baltimore. 343 *N. Eutaw St.*
Mr. G. G. Carey's School.

WILLIAM L. GLENN. Mr. G. G. Carey's School.	Baltimore.	153 *N. Charles St.*
BASIL B. GORDON. Mr. H. W. Luckett, Instructor.	Baltimore.	27 *Franklin St.*
WILLIAM C. L. GORTON. Baltimore City College, 1883.	Baltimore.	88 *S. Ann St.*
JOSEPH E. HARRY. Maryland Normal School.	Pylesville.	4 *McCulloh St.*
BENJAMIN H. HARTOGENSIS. Baltimore City College, 1883.	Baltimore.	10 *Harrison St.*
JOHN HINKLEY. Mr. G. G. Carey's School.	Baltimore.	287 *N. Charles St.*
JAMES S. HODGES.* St. Paul's School, Concord, N. H.	Baltimore.	83 *Saratoga St.*
JUNIUS M. HORNER.* University of Virginia.	Oxford, N. C.	54 *McCulloh St.*
THEODORE HOUGH. Mr. W. S. Marston's School.	Baltimore.	181 *McCulloh St.*
CHARLES H. HOWARD. Mr. W. S. Marston's School.	Baltimore.	101 *N. Charles St.*
ROBERT C. JOHNSTON. Mr. W. S. Marston's School.	Baltimore.	82 *Franklin St.*
ARTHUR L. LAMB.* Mr. E. M. Lamb, Instructor.	Baltimore.	187 *McCulloh St.*
JAMES A. LOANE. Baltimore City College, 1882.	Baltimore.	410 *N. Eden St.*
JOHN D. LORD, JR. Mr. M. A. Newell, Instructor.	Baltimore.	145 *Arlington Av.*
WILLIAM P. LYONS. Loyola College.	Baltimore.	377 *N. Gilmor St.*
ALLAN MCLANE. Mr. H. W. Luckett, Instructor.	Baltimore.	87 *Cathedral St.*
EDGAR G. MILLER, JR. Friends' Academy.	Baltimore.	279 *W. Baltimore St.*
WILLIAM R. ORNDORFF. Baltimore City College, 1881.	Baltimore.	218 *Gilmor St.*
GEORGE D. PENNIMAN. Baltimore City College.	Howard County.	*St. Denis P. O.*
WILLIAM H. PERKINS. Mr. W. S. Marston's School.	Baltimore.	207 *Franklin St.*
JOHN PLEASANTS. Mr. W. S. Marston's School.	Baltimore.	66 *Mt. Vernon Place.*
RICHARD H. PLEASANTS.* Mr. H. W. Luckett, Instructor.	Baltimore.	40 *Cathedral St.*
HARRY W. PRICE.* Baltimore City College, 1883.	Baltimore.	295 *Myrtle Av.*
MOSES R. RYTTENBERG.* Baltimore City College, 1882.	Baltimore.	72 *N. Front St.*
HUGO STEINER. Baltimore City College.	Baltimore.	23 *Hollins St.*
GEORGE C. STOKES, JR. Dr. J. C. M. Mérillas, Instructor.	Govanstown.	*Govanstown.*
FREDERICK H. WILKENS. Friends' High School, 1882.	Baltimore.	266 *W. Lombard St.*
LANGDON WILLIAMS.* Mr. W. S. Marston's School.	Boston, Mass.	74 *Cathedral St.*
WILLIAM K. WILLIAMS.* Mr. W. S. Marston's School.	Boston, Mass.	74 *Cathedral St.*
HENRY F. WINGERT.* Washington County High School.	Hagerstown.	211 *W. Biddle St.*
ALLAN C. WOODS. Mr. G. G. Carey's School.	Baltimore.	374 *Eutaw Pl.*

*Conditionally.

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NON-MATRICULATES.

Course Preliminary to the Study of Medicine

(Graduates and Matriculates pursuing this Course are enrolled above.)

WILLIAM W. DONALDSON. Princeton College.	Baltimore.	108 *Park Av.*
JERE W. LORD. Mr. M. A. Newell, Instructor.	Baltimore.	145 *Arlington Av.*
ELBERT T. RIDDICK.* Baltimore City College.	Hertford, N. C.	172 *Linden Av.*
AUDLEY H. STOW.* Baltimore City College.	Baltimore.	435 *N. Mount St.*
J. TASSEY WALTEMEYER.* Friends' High School.	Baltimore.	463 *N. Carey St.*
JOHN R. WINSLOW. Friends' School, Providence, R. I.	Baltimore.	23 *McCulloh St.*

*Conditionally

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Special Students.

W. LLOYD BEVAN, Rev. W. Kirkus, Instructor. *Languages.*	Baltimore.	101 *W. Lanvale St.*
THOMAS L. COLE. Virginia Theological Seminary. *Hebrew and Greek.*	Baltimore.	65 *McCulloh St.*
ARTHUR T. COLLINS. Private Instruction. *Chemistry.*	Mt. Washington.	*Mt. Washington.*
J. HILL DAWSON. Princeton College. *History and Political Science.*	Baltimore.	70 *W. Madison St.*
ALBERT A. DOUB. Washington County High School. *History.*	Hagerstown.	268 *W. Fayette St.*
JOHN L. DRAIN. E. Deichmann, Ph.D., Instructor. *History.*	Havana, Cuba.	1 *Pearl St.*
GEORGE W. EDMOND. Amherst College. *Chemistry and Biology.*	Portland, Me.	266 *N. Howard St.*
JAMES A. FINK. Holy Cross College, (Worcester, Mass.) *History.*	Baltimore.	221 *Franklin St*
HENRY A. FREDERICK. Phillips Academy, Andover. *History.*	Douglass, Pa.	358 *N. Eutaw St.*
JACOB GRAPE, JR. Baltimore City College, 1878.	Baltimore.	97 *Hillen St.*
JOHN S. HUGHES. Baltimore City College. *History and Political Science.*	Baltimore.	238 *Madison Av.*
PHILIP H. FRIESE. Instructor in Baltimore City College. *Philosophy, etc.*	Baltimore.	158 *N. Stricker St.*
JOHN H. LAESSIG. Maryland College of Pharmacy. *Chemistry.*	Baltimore.	419 *W. Fayette St.*
WILLIAM B. D. PENNIMAN. Baltimore City College. *Physics.*	Howard County.	*St. Denis P. O.*
JOHN H. RAMSBURG. Private Instruction. *Chemistry and Physics.*	Frederick.	172 *W. Fayette St*
BENJAMIN T. ROBERTS, JR. University of Rochester. *Latin, etc.*	North Chili, N. Y.	259 *Madison Av.*
DAVID E. ROBERTS. Pennsylvania State College. *Chemistry.*	Baltimore.	7 *Tyne St.*
CHARLES H. SHINN. University of California. *History and Political Science.*	San Francisco, Cal.	8 *McCulloh St.*
HENRY R. SLACK, JR. Maryland College of Pharmacy. *Chemistry.*	La Grange, Ga.	82 *N. Green St.*
S. TAGART STEELE. University of Virginia. *Biology.*	Baltimore.	92 *W. Madison St.*
MICHAEL D. STEIN. University of California. *Greek and Latin.*	Pittsburg, Pa.	144 *Park Av.*
JAMES E. TALMAGE. Lehigh University. *Chemistry and Biology.*	Provo City, Utah.	147 *Eutaw St.*
WILLIAM J. THOMAS. Randolph-Macon. *History and Political Science.*	Baltimore.	10 *S. Calhoun St.*
HENRY M. THOMAS. Haverford College. *Biology.*	Baltimore.	317 *Madison Av.*

William Walz. Baltimore City College. *Greek and Latin.*	Baltimore.	288 *E. Madison St.*
Henry H. Wiegand. Baltimore City College. *Chemistry.*	Baltimore.	272 *Madison Av.*
Douglas M. Wylie. Baltimore City College. *History.*	Baltimore.	215 *Franklin St.*

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SUMMARY.

Academic Staff.

President and Professors,	8
Lecturers,	9
Associate Professors,	8
Associates,	8
Instructors and Assistants,	10
	43

Enrolled Students.

Graduates (including Fellows),	148
Matriculates,	52
Non-Matriculates,	33
	233

The attendance upon the various courses of instruction as shown by the schedule of classes is as follows:

Mathematics,	35	German,	57
Physics,	55	Romance Languages,	30
Chemistry,	51	English,	46
Biology,	42	History and Political Science,	85
Greek,	36	Philosophy, Logic, etc.,	16
Latin,	36	Drawing,	30
Sanskrit, etc.,	15	Elocution,	42
Shemitic Languages,	9		

Enrolled Students—1876-83.

	Graduates (including Fellows).	Matriculates.	Non-Matriculates.	Total Enrolled.	Average Attendance upon Public Lectures.
1876-77.....	54	12	23	89	60
1877-78.....	58	24	22	104	84
1878-79.....	63	25	35	123	96
1879-80.....	79	32	48	159	113
1880-81.....	102	37	37	176	186
1881-82.....	99	45	31	175	137
1882-83.....	125	49	30	204	148
1883-84*...	148	52	33	233	—

* At the opening of the academic year.

Classification by Residences of Students.

Maryland, (Baltimore, 94),	115	Maine,	2
New York,	17	Minnesota,	2
Pennsylvania,	12	Nebraska,	2
Massachusetts,	10	Vermont,	2
North Carolina,	8	Alabama,	1
New Jersey,	5	Colorado,	1
Ohio,	5	Louisiana,	1
Iowa,	4	New Hampshire,	1
Kentucky,	4	Utah,	1
South Carolina,	4	West Virginia,	1
Georgia,	3		
Indiana,	3	Canada,	3
Michigan,	3	Germany,	3
Virginia,	3	Cuba,	1
Wisconsin,	3	England,	1
California,	2	France,	1
Connecticut,	2	Italy,	1
District of Columbia,	2	Japan,	1
Illinois,	2	Russia,	1

Students Enrolled above have been Graduated in the Institutions below named:

Johns Hopkins University,	25	University of Göttingen,	1
University of Maryland,	6	Highland University, (Kansas),	1
Amherst College,	5	Hope College, (Mich.)	1
Princeton College,	5	Illinois Wesleyan University,	1
University of Michigan,	4	Indiana Asbury University,	1
Norwegian Luther College,	4	Iowa College,	1
University of Pennsylvania,	4	Kentucky Wesleyan University,	1
Yale College,	4	University of Leipsic,	1
Harvard University,	3	University of Louisiana,	1
Haverford College,	3	Massachusetts Agricultural College,	1
University of North Carolina,	3	Mercer University,	1
Ohio Wesleyan University,	3	University of Minnesota,	1
U. S. Naval Academy,	3	McGill University,	1
University of Wisconsin,	3	Moore's Hill College,	1
Cornell University,	2	Muhlenberg College,	1
Davidson College,	2	University of Nebraska	1
Erskine College,	2	College of City of New York,	1
Lafayette College,	2	Newberry College,	1
University of Munich,	2	New Brunswick Theol. Seminary,	1
Swarthmore College,	2	Pennsylvania State College,	1
University of Vermont,	2	Randolph Macon College,	1
University of Virginia,	2	Rensselaer Polytechnic Institute,	1
Wake Forest College, (N. C.)	2	University of Rochester,	1
Williams College,	2	St. John's College, (Md.)	1
Beloit College,	1	St. Lawrence University,	1
Boston University,	1	University of Toronto,	1
Central University, (Ky.)	1	Trinity College, (Conn.)	1
Bellevue Hospital Medical College,	1	Trinity College, (N. C.)	1
Buchtel College, (Ohio),	1	Washington and Lee University,	1
University of Cambridge, (England),	1	Wesleyan University, (Conn.)	1
University of Colorado,	1	Victoria University, (Canada),	1
Columbia College,	1	Western Maryland College,	1
Geneva College, (Pa.)	1	College of Physicians and Surg. (Balto.)	1
Georgetown College, (Ky.)	1		

RECENT APPOINTMENTS.

Dr. Paul Haupt, Professor of Assyriology in the University of Göttingen, having accepted a call to the Johns Hopkins University as Professor of the Shemitic Languages, entered upon his duties in September. Nine students are now enrolled under his instruction. Classes are organized in Hebrew, Arabic, Assyrian, Ethiopic, and Sumero-Accadian. A special room has been set apart as a library and working room for those who are engaged in Oriental Studies under the direction of Dr. Haupt in the Shemitic tongue, and of Dr. Bloomfield in Sanskrit and the cognate languages.

The enlarged facilities of the Biological Laboratory, and the call of Dr. Sedgwick to Boston after the announcements for the year were made, have caused several changes in the Biological staff, which, as organized for the current year, is as follows:

Director, H. N. Martin, Professor of Biology.

Director of the Chesapeake Zoological Laboratory, W. K. Brooks, Associate Professor of Biology.

Lecturer for the current year on Botany, Professor William Trelease, of the University of Wisconsin.

Lecturer on Psychology, Dr. G. Stanley Hall.

Assistants, H. H. Donaldson, H. W. Conn, and Otto Lugger.

The persons below named have been appointed by the University teachers of Modern Languages:

German: G. Theodore Dippold, Ph. D., Boston University, 1883, late Instructor in the Boston University.

French: Henry A. Todd, A. B., Princeton College, 1876, Fellow and Tutor in Princeton College, 1876-80.

In addition to the facilities heretofore given, a conversational class has been formed in German by Dr. Lehmann, and in French by Mr. Fontaine, under the guidance respectively of Mr. Elliott and Dr. Wood.

The following promotions and appointments of gentlemen recently connected with the Johns Hopkins University have been reported at the office, viz.:

Edward Barnes, Graduate Student, 1882-83, *Professor of the Higher Mathematics in the Rose Polytechnic Institute, Terre Haute, Indiana.*

William H. Carpenter, Fellow by Courtesy, 1881-83, *Instructor in the Scandinavian Languages in Columbia College.*

R. Dorsey Coale, Ph. D., 1881, Fellow and Assistant, 1880-83, *Lecturer on Chemistry in the University of Maryland.*

William C. Day, A. B., 1880, Ph. D., 1883, Fellow, 1881-83, *Professor of Chemistry and Physics in St. John's College, Annapolis, Maryland.*

George S. Ely, Ph. D., 1883, Fellow, 1881-83, *Professor of Mathematics in Buchtel College, Ohio.*

William S. Fleming, Fellow, 1882-83, *Professor of Greek and German in Davidson College.*

Kakichi Mitsukuri, Ph. D., 1883, Fellow, 1880-81, *Professor of Zoology in the University of Tokio, Japan.*

William A. Noyes, Ph. D., 1882, *Professor of Chemistry in the University of Tennessee.*

Bernard F. O'Connor, Ph. D., 1883, Fellow, 1880-82, *Instructor in French in Columbia College.*

William T. Sedgwick, Ph. D., 1881, Fellow, Assistant, and Associate in Biology, 1879-83, *Assistant Professor of Biology in the Massachusetts Institute of Technology.*

ENUMERATION OF CLASSES, FIRST HALF-YEAR, 1883–4.

Mathematics. (35 Students).

Classes meet in Rooms 8 and 16.

Algebra of Multiple Quantity: PROFESSOR SYLVESTER. Twice weekly, Tuesday and Friday, 4 p. m. (6).

Bissing.	Davis.	Hathaway.	Howell, E. C.
Daniels.	Durfee.		

Mathematical Astronomy: DR. STORY. Three times weekly, Monday, Wednesday, and Friday, 12 m. (2).

Bissing.	Nixon.

Theory of Invariants: DR. STORY. Three times weekly, Monday, Wednesday, and Friday, 10 a. m. (6).

Bissing.	Davis.	Hathaway.	Howell, E. C.
Daniels.	Durfee.		

Conic Sections: DR. STORY. Twice weekly, Tuesday and Thursday, 1 p. m. (14).

Ames.	Faerber.	Horner.	Peed.
De Witt.	Gilbert.	McDaniel.	Warner.
Dohme.	Gorton.	Outen.	Wingert.
Eichelberger.	Haldeman.		

Higher Plane Curves: DR. STORY. Twice weekly, Tuesday and Thursday, 11 a. m. (2).

Faerber.	Nixon.

Theoretical Dynamics: DR. CRAIG. Twice weekly, Tuesday and Thursday, 10 a. m. (5).

Daniels.	Durfee.	Hathaway.	Nixon.
Davis.			

Mathematical Theory of Sound: DR. CRAIG. Three times weekly, Monday, Wednesday, and Friday, 11 a. m. (5).

Bissing.	Liebig, G. A.	Perkins, C. A.	Reid.
Duncan.			

Elliptic Functions: DR. CRAIG. Three times weekly, Monday, Wednesday, and Friday, 1 p. m. (4).

Daniels.	Faerber.	Hathaway.	Nixon.

Mechanics: DR. FRANKLIN. Three times weekly, Tuesday, Thursday, and Friday, 10 a. m. (6).

Duncan.	Hall.	Morrill.	Perkins, C. A.
Ellinger.	Liebig, G. A.		

Total Differential Equations: DR. FRANKLIN. Twice weekly, Tuesday and Thursday, 11 a. m. (6).

Crum.	Peed.	Pratt.	Rieman.
Ellinger.	Perkins, W. H.		

Determinants and Theory of Equations: DR. FRANKLIN. Three times weekly, Monday, Wednesday, and Friday, 11 a. m. (9).

Crum.	Faerber.	Morrill.	Pratt.
De Witt.	Hall.	Peed.	Warner.
Ellinger.			

Differential and Integral Calculus: DR. FRANKLIN. Three times weekly, Monday, Wednesday, and Friday, 1 p. m. (16).

Ames.	Gilbert.	Horner.	Palmer, A. G.
De Witt.	Gorton.	McDaniel.	Rieman.
Dohme.	Haldeman.	Newson.	Warner.
Eichelberger.	Hillyer.	Outen.	Wingert.

Physics. (55 Students).

Classes meet in Rooms 3, 4, 7, 8, 9.

Thermodynamics: PROFESSOR ROWLAND. Four times weekly, Monday, Tuesday, Thursday, and Friday, 9 a. m. (10).

Davis.	Ellinger.	Liebig, G. A.	Perkins, C. A.
Duncan.	Hathaway.	Morrill.	Reid.
Durfee.	Kimball.		

Laboratory Work: PROFESSOR ROWLAND. Daily. (10 advanced students).

Duncan.	Kimball.	Perkins, C. A.	Reid.
Ellinger	Liebig, G. A.	Pratt.	Rieman.
Goodnow.	Morrill.		

Major Course: DR. HASTINGS. Lecture, once weekly, Thursday, 4 p. m. Laboratory work daily, especially Tuesdays. (16).

Crum.	Emerson, W. H.	Keiser.	Pratt.
Day, D. T.	Faerber.	Newson.	Rieman.
De Witt.	Hall.	Nixon.	Warner.
Ellinger.	Hathaway.	Peed.	Webster.

General Physics: Minor Course: DR. HASTINGS. Daily, 10 a. m. (30).

Ames.	Fadeley.	McDaniel.	Riddick.
Bayard.	Gates.	Outen.	Roberts, D. E.
Brackett.	Gorton.	Penniman, G. D.	Smedes.
Buckler.	Hartogensis.	Penniman, W. B. D.	Stamps.
Canfield.	Horner.	Perkins, W. H.	Waltemeyer.
Donaldson, W. W.	Laessig.	Pleasants, R. H.	Winslow.
Eichelberger.	Lamb.	Ramsburg.	Woods.
Fink.	Lyons.		

Laboratory Work: (*Class in General Physics*): DR. HASTINGS and MR. REID. (29).

Ames.	Gates.	McDaniel.	Riddick.
Brackett.	Gorton.	Outen.	Roberts, D. E.
Buckler.	Hartogensis.	Penniman, G. D.	Smedes.
Canfield.	Horner.	Penniman, W. B. D.	Stamps.
Donaldson, W. W.	Laessig.	Perkins, W. H.	Waltemeyer.
Eichelberger.	Lamb.	Pleasants, R. H.	Winslow.
Fink.	Lyons.	Ramsburg.	Woods.
Fadeley.			

Chemistry. (51 Students).

Classes meet in the Chemical Laboratory.

Laboratory Work: PROFESSOR REMSEN and DR. MORSE. Daily. (51).

Applegarth.	Emerson, W. H.	Newson.	Slack.
Bayley.	Gilbert.	Orndorff.	Smedes.
Boyd.	Gordon.	Palmer, A. G.	Stamps.
Brackett.	Hartogensis.	Piggot.	Steiner.
Bruce, J. D.	Hillyer.	Pleasants, J.	Stevens.
Campbell.	Hinkley.	Ramsburg.	Stokes, H. N.
Canfield.	Johnston, R. C.	Rieman.	Talmage.
Coale.	Keiser.	Roberts, D. E.	Walz.
Collins.	Laessig.	Ryttenberg.	Webster.
Day, D. T.	McClintock.	Sanger.	Wiegand.
Dinsmore.	Miller, E. G.	Schaeffer.	Wylie.
Duggan.	Miller, J. S.	Schubart.	Yonce.
Edmond.	Mills.	Simpson.	

General Chemistry: PROFESSOR REMSEN. Daily, except Friday, 9 a. m. (27).

Brackett.	Hartogensis.	Rieman.	Stamps.
Canfield.	Hinkley.	Roberts, D. E.	Steiner.
Dinsmore.	Miller, E. G.	Ryttenberg.	Talmage.
Edmond.	Miller, J. S.	Sanger.	Walz.
Emerson, W. H.	Orndorff.	Schaeffer.	Webster.
Gilbert.	Pleasants, J.	Slack.	Wylie.
Gordon.	Ramsburg.	Smedes.	

Physical Chemistry and Chemical Philosophy: PROFESSOR REMSEN. Lecture, once weekly, Friday, 9 a. m. (32).

Bayley.	Emerson, W. H.	Newson.	Schubart.
Boyd.	Gordon.	Orndorff.	Simpson.
Brackett.	Hillyer.	Palmer, A. G.	Slack.
Campbell.	Johnston, R. C.	Piggot.	Smedes.
Collins.	Keiser.	Rieman.	Stamps.
Day, D. T.	Laessig.	Roberts, D. E.	Stokes, H. N.
Duggan.	Miller, J. S.	Sanger.	Talmage.
Edmond.	Mills.	Schaeffer.	Webster.

Analytical Chemistry: DR. MORSE. Four times weekly, Monday, Tuesday, Wednesday, and Thursday, 9 a. m. (8).

Boyd.	Hillyer.	Laessig.	Newson.
Campbell.	Johnston, R. C.	Mills.	Schubart.

Mineralogy: Dr. Williams. Lectures three times weekly, Monday, Wednesday, and Friday, 4 p. m., and practical work, Saturday 9 a. m. to 12 m. (9).

Bayley.	Newson.	Piggot.	Talmage.
Collins.	Palmer, A. G.	Sanger.	Yonce.
Hillyer.			

Biology. (42 Students.)

Classes meet in the Biological Laboratory.

General Biology: Professor Martin. Three times weekly, Monday, Tuesday, and Thursday, 11 a. m. (19).

Abel.	Duggan.	Johnston, R. C.	Slack.
Andrews.	Edmond.	McClintock.	Steele, S. T.
Bruce, A. T.	Haldeman.	Miller, J. S.	Talmage.
Boyd.	Hanna.	Nelson.	Webster.
Campbell.	Jayne.	Roberts, B. T.	

Animal Physiology and Histology: Professor Martin. Three times weekly, Monday, Wednesday, and Friday, 10 a. m. (12).

Abel.	Friedenwald.	Jastrow.	McClintock.
Andrews.	Hanna.	Kemp.	Nelson.
Bruce, A. T.	Jayne.	Lord, J. W.	Wilson, H. V.

Animal Morphology: Dr. Brooks. Twice weekly, Monday and Thursday, 9 a. m. (12).

Andrews.	Howell, W. H.	Lee.	Nelson.
Bruce, A. T.	Jayne.	Mills.	Osborn, H. L.
Conn.	Kemp.	Nachtrieb.	Stevens.

Mammalian Anatomy: Mr. Conn. Twice weekly, Tuesday and Thursday, 10 a. m. (8).

Abel.	Friedenwald.	Lord, J. W.	Nelson.
Andrews.	Kemp.	McClintock.	Wilson, H. V.

Osteology: Mr. Conn. Twice weekly, Wednesday and Friday, 11 a. m. (10).

Andrews.	Haldeman.	Miller, J. S.	Roberts, B. T.
Boyd.	Johnston, R. C.	Nelson.	Talmage.
Campbell.	McClintock.		

Laboratory Work: Professor Martin, Mr. Donaldson, Mr. Conn. Daily, 9 a. m. to 5 p. m. (31).

Abel.	Edmond.	Kemp.	Osborn, H. L.
Andrews.	Friedenwald.	Lee.	Roberts, B. T.
Beyer.	Haldeman.	Lord, J. W.	Steele, S. T.
Boyd.	Hanna.	McClintock.	Stevens.
Bruce, A. T.	Howell, W. H.	Miller, J. S.	Talmage.
Campbell.	Jastrow.	Mills.	Webster.
Donaldson, F.	Jayne.	Nachtrieb.	Wilson, H. V.
Duggan.	Johnston, R. C.	Nelson.	

Marine Laboratory: Dr. Brooks. At Hampton, Va., during the summer months. (15).

Bateson.	Lee.	Osborn, H. L.	Tuttle.
Conn.	McMurrich.	Pillsbury.	Wilson, H. V.
Earle.	Mills.	Sewall.	Winslow.
Jenkins.	Nachtrieb.	Stratton.	

Greek. (36 Students).

Classes meet in 181 N. Howard St.

Seminary: Professor Gildersleeve. Twice weekly, Monday and Wednesday, 12 m. (13).

Arnolt.	Huizinga.	Lodge.	Miller, C. W. E.
Emerson, A.			
Baden.	Glenn, J.	Holstad.	Slaughter.
Elmer.	Graves.	Osborne, W. H.	Stout.

Historiography: Professor Gildersleeve. Weekly, Thursday, 12 m. (12).

Arnolt.	Emerson, A.	Holstad.	Osborne, W. H.
Baden.	Glenn, J.	Huizinga.	Slaughter.
Elmer.	Graves.	Miller, C. W. E.	Stout.

Composition and Translation: Professor Gildersleeve. Twice weekly, Tuesday and Friday, 10 a. m. (10).

Arnolt.	Graves.	Lodge.	Slaughter.
Elmer.	Holstad.	Miller, C. W. E.	Stout.
Glenn, J.	Huizinga.		

Thucydides, bk. vii: Professor C. D. Morris. Four times weekly, Tuesday, Wednesday, Thursday, and Friday, 12 m. (12).

Bevan.	Glenn, J.	McLane.	Slaughter.
Fink.	Howard.	Pease.	Walz.
Fossum.	Loane.	Roberts, B. T.	Wilkens.

Homer: *Iliad:* Professor C. D. Morris. Weekly, Wednesday, 9 a. m. (6).

Alden.	Egge.	Stein.	Tolman.
Dunlap.	Fossum.		

Lysias: Dr. Spieker. Four times weekly, Tuesday, Wednesday, Thursday, and Friday, 11 a. m. (8).

Fossum.	Hodges.	Hough.	Williams, L.
Harry.	Horner.	Stein.	Williams, W. K.

New Testament Criticism: Mr. Harris. Twice weekly, Tuesday and Thursday, 9 a. m. (5).

Bevan.	Glenn, W. L.	James.	Stout.
Dunlap.			

Prose Composition:

Class A. Professor C. D. Morris. Weekly, Monday, 12 m. (10).

Bevan.	Glenn, J.	McLane.	Walz.
Fink.	Howard.	Roberts, B. T.	Wilkens.
Fossum.	Loane.		

Class B. Dr. Spieker. Weekly, Monday, 11 a. m. (8).

Fossum.	Hodges.	Hough.	Williams, L.
Harry.	Horner.	Stein.	Williams, W. K.

Classical Antiquities: Dr. Emerson. Twice weekly, Tuesday and Thursday, 4 p. m. (4).

Lodge.	Pease.	Slaughter.	Wilkens.

Latin. (36 Students).

Classes meet in 181 N. Howard St.

Seminary: *Terence:* Dr. Warren. Twice weekly, Tuesday and Friday, 11 a. m. (12).

Baden.	Holstad.	Miller, C. W. E.	Slaughter.
Elmer.	Huizinga.	Osborne, W. H.	Stout.
Graves.	Lodge.	Pease.	Zweizig.

Palaeography: Dr. Warren. Weekly, Wednesday, 11 a. m. (10).

Elmer.	Lodge.	Pease.	Stout.
Graves.	Miller, C. W. E.	Slaughter.	Zweizig.
Holstad.	Osborne, W. H.		

Aulus Gellius: Dr. Warren. Weekly, Thursday, 10 a. m. (10).

Elmer.	McLane.	Roberts, B. T.	Stout.
Glenn, J.	Pease.	Slaughter.	Walz.
Graves.	Pleasants, J.		

Cicero and Pliny's Letters: Dr. Warren. Three times weekly, Tuesday, Wednesday, and Friday, 10 a. m. (5).

Glenn, J.	Pleasants, J.	Roberts, B. T.	Walz.
McLane.			

The meetings on Wednesday are devoted to reading Latin at sight.

Lucretius: Professor C. D. Morris. Four times weekly, Tuesday, Wednesday, Thursday, and Friday, 10 a. m. (4).

Bevan.	Loane.	Stein.	Wilkens.

The meetings on Wednesday are devoted to reading Latin at sight.

Livy: Dr. Spieker. Four times weekly, Tuesday, Wednesday, Thursday, and Friday, 9 a. m. (15).

Doub.	Frederick.	Howard.	Williams, L.
English.	Harry.	Pleasants, R. H.	Williams, W. K.
Fadeley.	Hodges.	Price.	Woods.
Fifield, J. C.	Hough.	Scaife.	

Prose Composition:

Class A: Dr. Warren. Weekly, Monday, 10 a. m. (5).

Glenn, J.	Pleasants, J.	Roberts, B. T.	Walz.
McLane.			

Class B: Professor C. D. Morris. Weekly, Monday, 10 a. m. (4).

Bevan.	Loane.	Stein.	Wilkens.

Class C: DR. SPIEKER. Weekly, Monday, 9 a. m. (15).

Doub.	Frederick.	Howard.	Williams, L.
English.	Harry.	Pleasants, R. H.	Williams, W. K.
Fadeley.	Hodges.	Price.	Woods.
Fifield, J. C.	Hough.	Scaife.	

Shemitic Languages. PROFESSOR HAUPT. (9 Students).

Assyriological Exercises. (For advanced Assyriologists, including reading at sight of bilingual texts). Two hours weekly, Saturday, 12–2 p. m. (1).
Lehmann.

Sumero-Accadian: Weekly, Monday, 2–4 p. m. (4).

Adler.	Arnolt.	Frothingham.	Lehmann.

Assyrian: Twice weekly, Tuesday and Thursday, 3 p. m. (5).

Adler.	Gaebelein.	Frothingham.	Lehmann.
Arnolt.			

Arabic: Weekly, Wednesday, 3 p. m. (5).

Adler.	Cole.	Huizinga.	Lehmann.
Arnolt.			

Hebrew: Twice weekly, Tuesday and Thursday, 4 p. m. (8).

Adler.	Cole.	Grape.	Huizinga.
Arnolt.	Frothingham.	Harris.	Lehmann.

Ethiopic: Weekly, Wednesday, 4 p. m. (6).

Adler.	Frothingham.	Harris.	Lehmann.
Arnolt.	Gaebelein.		

Sanskrit and the comparative grammar of the cognate languages. DR. BLOOMFIELD. (15 Students).

Classes meet in 187 N. Howard St.

Elementary Sanskrit: Twice weekly, Tuesday, 9 a. m.; Friday, 12 m. (4).

Adler.	Huizinga.	Jagemann.	Tolman.

Advanced Sanskrit:

Çakuntala: Weekly, Saturday, 10 a. m. (3).

Spieker.	Todd.	Warren, H. C.

Kâuçika-Sûtra (from the Manuscripts): Weekly, Tuesday, 3 p. m. (1).
Warren, H. C.

Rig Veda: Weekly, Wednesday, 10 a. m. (4).

Lehmann.	Spieker.	Todd.	Warren, H. C.

Pâli: Weekly, Thursday, 10 a. m. (1).
Warren, H. C.

Comparative Philology: Weekly, Monday, 4 p. m. (13).

Adler.	Evenson.	Jagemann.	Tolman.
Arnolt.	Holstad.	Lehmann.	Wilkens.
Burton.	Huizinga.	Spieker.	Wright.
Egge.			

German. (57 Students.)

Middle High German: DR. DIPPOLD. Twice weekly, Monday and Thursday, 9 a. m. (3).

Egge.	Gates.	Wright.

Stilübungen and Syntax: MR. RADDATZ. Second Wednesday of each month, 2.30 p. m. (5).

Dohme.	Friedenwald.	Gates.	Glenn, J.
Egge.			

Beast Epic and Middle Low German: DR. GERBER. Weekly, Wednesday, 4 p. m. (5).

Egge.	Emerson, A.	Tolman.	Wright.
Evenson.			

German Literature (*Lectures in German*): DR. DIPPOLD. Alternate Saturdays, 10 a. m. (11).

Arts.	De Witt.	Gates.	Tolman.
Bowen.	Dohme.	Loane.	Wright.
Cromwell.	Egge.	Miller, E. G.	

(*Major Course*).

Goethe: *Faust:* DR. DIPPOLD. Twice weekly, Tuesday and Friday, 10 a. m. (9).

Arts.	Cromwell.	Dohme.	Tolman.
Alden.	DeWitt.	Miller, E. G.	Wright.
Cobb.			

Lessing: *Nathan d. Weise:* DR. DIPPOLD. Twice weekly, Monday and Wednesday, 10 a. m. (6).

Arts.	De Witt.	Graves.	Miller, E. G.
Cromwell.	Dohme.		

Prose Composition: MR. RADDATZ. Weekly, Thursday, 2.30 p. m. (11).

Arts.	Dohme.	Glenn, J.	Tolman.
Cromwell.	Friedenwald.	Miller, E. G.	Wright.
De Witt.	Gates.	Perkins, W. H.	

(*Minor Course.*)

Schiller: *Maria Stuart:* DR. DIPPOLD. Twice weekly, Tuesday and Thursday, 11 a. m. (22).

Ames.	Fadeley.	Lyons.	Stow.
Burton.	Fifield, J. C	McDaniel.	Waltemeyer.
Cobb.	Fink.	Penniman, W. B. D.	Winslow.
Donaldson, W. W.	Gilbert.	Ramage.	Wiegand.
Doub.	Hartogensis.	Riddick.	Wingert.
English.	Lord, J. D.		

Goethe: *Egmont:* DR. DIPPOLD. Twice weekly, Wednesday and Friday, 11 a. m. (20).

Ames.	Fifield, J. C.	Lyons.	Stow.
Donaldson, W. W.	Fink.	McDaniel.	Waltemeyer.
Doub.	Gilbert.	Penniman, W. B. D.	Winslow.
English.	Hartogensis.	Riddick.	Wiegand.
Fadeley.	Lord, J. D.	Smedes.	Wingert.

Prose Composition: MR. RADDATZ. Weekly, Friday, 2.30 p. m. (24).

Ames.	English.	Johnston, R. C.	Riddick.
Cobb.	Fifield, J. C.	Lord, J. D.	Slaughter.
Donaldson, W. W.	Fink.	Lyons.	Stow.
Doub.	Gilbert.	McDaniel.	Waltemeyer.
Eichelberger.	Gorton.	Penniman, W. B. D.	Wiegand.
Ellinger.	Hartogensis.	Price.	Winslow.

Minor Course: *Second Section:* DR. DIPPOLD. Thrice weekly, Monday, Wednesday, and Thursday, 2.30 p. m. (15).

Brackett.	Cobb.	Lamb.	Slaughter.
Brice.	Doub.	Newson.	Waller.
Buckler.	Dunlap.	Outen.	Williams, W. K.
Burton.	English.	Sato.	

Classes for German Conversation meet twice weekly, Wednesday and Saturday, 9 a. m.

Romance Languages. (80 Students).

Classes meet in 111 W. Monument St.

Advanced Courses: *Provençal: Anglo Norman: Old French: Portuguese:* MR. ELLIOTT. (4 classes.) Four times weekly, Monday, Tuesday, Wednesday, and Thursday, 10 a. m. (5).

Bowen.	Jagemann.	Osborne, W. H.	Warren, F. M.
Fontaine.			

Advanced Courses: *Spanish and Portuguese Dialects: Comparative Grammar of Romance Languages: Ladinian:* MR. ELLIOTT. (8 classes.) Three times weekly, Tuesday, Wednesday, and Thursday, 11 a. m. (5).

Bowen.	Jagemann.	Todd.	Warren, F. M.
Fontaine.			

French Philology, Phonetics, etc.: MR. ELLIOTT. Weekly, Monday, 9 a. m. (8).

Bevan.	Fink.	Lyons.	Warren, F. M.
Bowen.	Fontaine.	Osborne, W. H.	Wiegand.

Italian: MR. TODD. Three times weekly, Monday, Tuesday, and Wednesday, 9 a. m. (9).

Bowen.	Kemp.	Perkins, W. H.	Wiegand.
Fink.	Lyons.	Warren, F. M.	Wilkens.
Fontaine.			

Spanish: MR. TODD. Twice weekly, Thursday and Friday, 9 a. m. (8).

Arnolt.	Kemp.	Lord, J. W.	Warren, F. M.
Bowen.	Lord, J. D.	Perkins, W. H.	Wilkens.

French: Major Course: MR. TODD. Four times weekly, Tuesday, Wednesday, Thursday, and Friday, 1 p. m. (6).

Bevan.	Fink.	Osborne, W. H.	Wiegand.
Drain.	Lyons.		

French: Minor Course: MR. TODD. Daily, 12 m. (13).

Adler.	Egge.	Johnston, R. C.	Penniman, W. B. D.
Carey.	Fifield, J. C.	Laessig.	Pleasants, R. H.
Conn.	Hinkley.	Lord, J. D.	Stow.
Drain.			

One exercise weekly of both the Major and Minor Courses is devoted to Prose Composition. Classes for French Conversation also meet daily.

English. (46 Students.)

Classes meet in 111 W. Monument St.

Old Saxon: Heliand: DR. WOOD. Weekly, Thursday, 12 m. (4).

Egge.	Evenson.	Tolman.	Wright.

Anglo-Saxon: Advanced Course: Beowulf: DR. WOOD. Twice weekly, Monday and Wednesday, 10 a. m. (5).

Crum.	Evenson.	Tolman.	Wright.
Egge.			

(*Major Course*).

Anglo-Saxon: Sweet's Reader: DR. WOOD. Twice weekly, Monday and Wednesday, 12 m. (8).

Alden.	Burton.	Dunlap.	Stein.
Brice.	Cobb.	Gates.	Waller.

Early English: 1300-1400 *A. D.: Morris and Skeat's Specimens, Part* II.: DR. WOOD. Twice weekly, Tuesday and Friday, 12 m. (8).

Alden.	Burton.	Dunlap.	Gates.
Brice.	Cobb.	Egge.	Waller.

(*Minor Course*).

English Phonetics: DR. WOOD. Weekly, Monday, 11 a. m. (10).

Alden.	Cobb.	Gates.	Waller.
Brice.	Cromwell.	Tolman.	Wilkens.
Burton.	Dunlap.		

Early English: Chaucer: DR. WOOD. Weekly, Wednesday, 11 a. m. (10).

Alden.	Cobb.	Gates.	Waller.
Brice.	Cromwell.	Stein.	Wilkens.
Burton.	Dunlap.		

Shakespeare: Hamlet: DR. BROWNE. Twice weekly, Tuesday and Thursday, 11 a. m. (9).

Alden.	Cobb.	Dunlap.	Waller.
Brice.	Cromwell.	Gates.	Wilkens.
Burton.			

Grammatical and Rhetorical Exercises: DR. WOOD. Weekly, Friday, 11 a. m. (10).

Brice.	Cromwell.	Gates.	Waller.
Burton.	Egge.	Stein.	Wilkens.
Cobb.	Fisher.		

English Literature: (*P. H. E. Course*): DR. BROWNE. Twice weekly, Wednesday and Thursday, 12 m. (31).

Ames.	English.	Horner.	Riddick.
Bayard.	Fadeley.	Hough.	Waltemeyer.
Buckler.	Fifield, J. C.	Howard.	Williams, L.
Cromwell.	Frederick.	Lamb.	Williams, W. K.
Doub.	Friedenwald.	McDaniel.	Winslow.
Dohme.	Gorton.	Orndorff.	Woods.
Donaldson, W. W.	Harry.	Price.	Wylie.
Eichelberger.	Hodges.	Pleasants, R. H.	

History and Political Science. (85 Students).

Seminary: DR. ADAMS. Weekly, Friday, 8-10 p. m., in Bluntschli Library. (32).

Alden.	Gould.	Randall.	Sollers.
Bemis.	Holcomb.	Rich.	Steel, W. B.
Berry.	Hebden.	Riggs.	Thomas, B. T.
Dewey, D. R.	Ingle.	Rose.	Warren, F. M.
Dewey, J.	Johnson, J.	Sato.	Wilhelm.
Dixon.	Kennard.	Scaife.	Wilson, W.
Fisher.	Levermore.	Shaw.	Worthington.
Goodman.	Ramage.	Shinn.	Yager.

American History: DR. ADAMS. Weekly, Thursday, 12 m., in Bluntschli Library. (27).

Alden.	Holcomb.	Riggs.	Thomas, W. J.
Bemis.	Ingle.	Sato.	Warren, F. M.
Berry.	Kennard.	Scaife.	Wilhelm.
Dewey, D. R.	Levermore.	Shaw.	Wilson, W.
Dixon.	Ramage.	Shinn.	Worthington.
Fisher.	Randall.	Steel, W. B.	Yager.
Gould.	Rich.	Thomas, B. T.	

Church History: DR. ADAMS. Twice weekly, Monday and Tuesday, 11 a. m., in Room 9. (22).

Alden.	Drain.	James.	Steiner.
Applegarth.	Fisher.	McLane.	Steel, W. B.
Artz.	Fossum.	Randall.	Thomas, B. T.
Bayard.	Glenn, J.	Riggs.	Warren, F. M.
Dawson.	Glenn, W. L.	Ryttenberg.	Worthington.
Dewey, D. R.	Holcomb.		

International Law: DR. ADAMS. Three times weekly, Monday, Tuesday, and Wednesday, 12 m., in Bluntschli Library. (26).

Artz.	Holcomb.	Randall.	Steel, W. B.
Berry.	Ingle.	Rich.	Thomas, B. T.
Dewey, D. R.	James.	Sato.	Wilhelm.
Dewey, J.	Kennard.	Scaife.	Wilson, W.
Dixon.	Levermore.	Shaw.	Worthington.
Drain.	Lyons.	Shinn.	Yager.
Gould.	Ramage.		

Political Economy: *Advanced Course:* DR. ELY. Three times weekly, Monday, Wednesday, and Friday, 4 p. m., in Bluntschli Library. (25).

Bemis.	Ingle.	Riggs.	Thomas, W. J.
Berry.	Kennard.	Sato.	Waller.
Brice.	Levermore.	Shaw.	Wilhelm.
Dewey, D. R.	Ramage.	Shinn.	Wilson, W.
Dixon.	Randall.	Steel, W. B.	Worthington.
Gould.	Rich.	Thomas, B. T.	Yager.
Holcomb.			

English Constitutional History: *Stubbs' Select Charters:* DR. JAMESON. Weekly, Friday, 12 m., in Room 9. (10).

Artz.	Lyons.	Thomas, B. T.	Worthington.
Dewey, D. R.	Randall.	Wilson, W.	Yager.
Levermore.	Scaife.		

English and French History: DR. JAMESON. Three times weekly, Wednesday, Thursday, and Friday, 11 a. m., in Room 9. (12).

Applegarth.	Dawson.	Howard.	Riggs.
Artz.	Drain.	McLane.	Ryttenberg.
Bayard.	Glenn, W. L.	Randall.	Steiner.

Political Economy: *Undergraduate Course:* DR. ELY. Daily, 1 p. m., in Room 9. (18).

Applegarth.	Drain.	Hughes.	Penniman, G. D.
Artz.	Glenn, W. L.	Kennard.	Price.
Brice.	Hinkley.	Lord, J. W.	Riggs.
Carey.	Holcomb.	Miller, E. G.	Scaife.
Dawson.	Howard.		

Introductory Historical Lectures: (*P. H. E. Course*): DR. ADAMS. Weekly, Friday, 12 m., in Room B, 111 W. Monument St. (34).

Ames.	Fisher.	Hughes.	Stein.
Bayard.	Friedenwald.	Lamb.	Waltemeyer.
Buckler.	Gorton.	McDaniel.	Williams, L.
Dohme.	Harry.	Orndorff.	Williams, W. K.
Donaldson, W. W.	Hartogensis.	Pleasants, R. H.	Wingert.
Doub.	Hodges.	Price.	Winslow.
Eichelberger.	Holcomb.	Riddick.	Woods.
English.	Horner.	Steel, W. B.	Wylie.
Fadeley.	Hough.		

Greek and Roman History: (*P. H. E. Course*): DR. JAMESON. Twice weekly, Monday and Tuesday, 12 m., in Room B, 111 W. Monument St. (31).

Ames.	Fadeley.	Hough.	Waltemeyer.
Bayard.	Frederick.	Hughes.	Williams, L.
Buckler.	Friedenwald.	Lamb.	Williams, W. K.
Dohme.	Gorton.	McDaniel.	Wingert.
Donaldson, W. W.	Harry.	Orndorff.	Winslow.
Doub.	Hartogensis.	Pleasants, R. H.	Woods.
Eichelberger.	Hodges.	Price.	Wylie.
English.	Horner.	Riddick.	

History of Philosophy, Logic, etc. (16 Students).

Classes meet in 187 N. Howard St.

Seminary (*Spinoza's Ethic*): PROFESSOR G. S. MORRIS. Twice weekly, Tuesday and Thursday, 12 m. (5).

Dewey, J. Jastrow. Ryttenberg. Steiner.
Fisher.

History of German Philosophy: PROFESSOR G. S. MORRIS. Three times weekly, Monday, Wednesday, and Friday, 4 p. m. (8).

Burton. Fisher. Jastrow. Ryttenburg.
Dewey, J. Friese. Osborn, H. L. Steiner.

History of Philosophy: PROFESSOR G. S. MORRIS. Twice weekly, Tuesday and Thursday, 4 p. m. (3).

Fisher. Friese. Kemp.

Logic (*Advanced Course*): MR. PEIRCE. Twice weekly, Tuesday and Friday, 9 a. m. (4.)

Dewey, J. Jastrow. Miller, C. W. E. Taber.

Philosophical Terminology: MR. PEIRCE. Lectures weekly, Thursday, 4 p. m. (2).

Dewey, J. Jastrow.

Logic (*Elementary Course*): MR. HARRIS. Daily, 1 p. m. (8).

Campbell. Kemp. Lord, J. W. Ryttenberg.
Friedenwald. Loane. Orndorff. Steiner.

Psychology, etc. DR. G. STANLEY HALL.

Classes to be formed in the second half-year.

Drawing. (30 Students).

MR. NEWELL. Daily, except Wednesday, 1 to 5 p. m.

(*Free-Hand Drawing*).

Andrews.	Glenn, W. L.	Laessig.	Pleasants, J.
Campbell.	Haldeman.	Lee.	Riddick.
Carey.	Hartogensis.	Nelson.	Stein.
Dohme.	Hillyer.	Osborn, H. L.	Thomas, B. T.
English.	Howell, W. H.	Penniman, G. D.	Winslow.
Fadeley.	Johnston, R. C.	Perkins, W. H.	Waltemeyer.
Glenn, J.			

(*Mechanical Drawing*).

Bissing.	Eichelberger.	Gorton.	McDaniel.
Crum.			

Elocution. (42 Students).

MR. WOODWORTH. Daily, 10 a. m. to 1 p. m.

Arts.	Doub.	Lee.	Price.
Bayard.	English.	Loane.	Roberts, B. T.
Bevan.	Fifield, J. C.	Lodge.	Scaife.
Bem's.	Fink.	Lyons.	Slaughter.
Bowen.	Fisher.	Orndorff.	Stein.
Canfield.	Frederick.	Osborn, H. L.	Tolman.
Cobb.	Frothingham.	Pease.	Waller.
Crowe.	Gerber, A.	Penniman, G. D.	Wiegand.
Dewey, J.	Glenn, W. L.	Perkins, W. H.	Williams, L.
Dixon.	Harry.	Pleasants, J.	Williams, W. K.
Dohme.	Kennard.		

Physical Culture. DR. HARTWELL. Daily.

Classes will meet as hereafter announced.

APPOINTMENTS OF SOCIETIES.

Scientific Association.

Professor Sylvester, President. Meets on the first Wednesday of each month in Hopkins Hall, 8 p. m.

Historical and Political Science Association.

Dr. H. B. Adams, Secretary. Meets weekly, Friday, in Bluntschli Library, 8 p. m.

Mathematical Society.

Professor Sylvester, President. Meets on the third Wednesday of each month in room 16, 8 p. m.

Metaphysical Society.

Professor G. S. Morris, President. Meets on the second Tuesday of each month in 187 N. Howard Street, 8 p. m.

Philological Association.

Professor Gildersleeve, President. Meets on the first Friday of each month in Bentley Hall, 12 m.

The NATURALISTS' FIELD CLUB meets as announced from time to time.

The SOCIETY for the study of ENGLISH PHILOLOGY meets alternate MONDAYS, at 8 p. m.

The SOCIETY for the study of SHEMITIC PHILOLOGY meets weekly, SATURDAY, at 8.30 p. m.

The CLUBS for READING the SCIENTIFIC JOURNALS meet as follows:

In Physics, weekly, Wednesday, 9 a. m.; *In Biology*, weekly, Wednesday, 9 a. m.; *In Chemistry*, as announced.

Meeting of the MARYLAND HISTORICAL SOCIETY, second Monday of each month, 8 p. m., corner of Saratoga and St. Paul Sts.,

Meeting of the MARYLAND ACADEMY OF SCIENCES, first and third Mondays of each month, 8 p. m., corner of Saratoga and St. Paul Sts.

CONSULTATION HOURS.

(Unless otherwise indicated the rooms designated are in the University Buildings, corner of Howard and Ross Streets.)

In order to promote economy of time, on the part of students as well as officers, brief consultations may be had with the gentlemen below-named at the hours and places indicated. In case prolonged conference is desirable, special appointments may be made, by notes exchanged at the registrar's office, or otherwise. The person named will usually be accessible for some minutes after the appointed hour. The appointments do not include Saturday.

Students are requested to call at the hours named, unless there are exceptional reasons for coming at some other time.

GILMAN, D. C.	*President's Office.*	1 p. m.
ADAMS, H. B.	*Bluntschli Library.*	9 a. m.
BLOOMFIELD, M.	123 *W. Madison St.*	12 m.
BROOKS, W. K.	*Biological Laboratory.*	11 a. m.
BROWNE, W. H.	*Library.*	9 a. m to 5 p. m.
CRAIG, T.	*Room* 18	12 m.
ELY, R. T.	*Bluntschli Library.*	1 p. m.
ELLIOTT, A. M.	111 *W. Monument St.*	12 m.
FRANKLIN, F.	*Room* 13.	12 m.
GILDERSLEEVE, B. L.	181 *Howard St.*	11 a. m.
HARRIS, J. R.	187 *Howard St.*	9 a. m.
HARTWELL, E. M.	*Registrar's Office.*	9 a. m.
HASTINGS, C. S.	*Room* 8.	11 a. m.
HAUPT, P.	113 *W. Monument St.*	(except Monday.) 5 p. m.
JAMESON, J. F.	*Bluntschli Library.*	12 m.
MARTIN, H. N.	*Biological Laboratory.*	12 m.
MORRIS, C. D.	181 *Howard St.*	11 a. m.
MORRIS, G. S.	187 *Howard St.*	1 p. m.
MORSE, H. N.	*Chemical Laboratory.*	2 p. m.
NEWELL, H.	*Room* 19.	(except Wed.) 1 p. m.
PEIRCE, C. S.	187 *Howard St.*	(Tues. and Fri.) 9 a. m.
RABILLON, L.	*Room* 8.	12 m.
REMSEN, I.	*Chemical Laboratory.*	11 a. m.
ROWLAND, H. A.	*Physical Laboratory.*	10 a. m.
SPIEKER, E. H.	181 *Howard St.*	10 a. m.
STORY, W. E.	*Room* 15.	(As posted at room) 11 a. m. and 12 m.
SYLVESTER, J. J.	*Room* 17.	3 p. m.
TODD, H. A.	111 *W. Monument St.*	12 m.
WARREN, M.	84 *W. Monument St.*	2 p. m.
WILLIAMS, G. H.	*Chemical Laboratory.*	9 a. m.
WOOD, H.	111 *W. Monument St.*	11 a. m.
WOODWORTH, C. L.	*Hopkins Hall.*	9 a. m. to 12 m.

Treasurer's and Registrar's Offices.

These offices are open daily, except Saturdays, from 9 a. m. to 6 p. m., and on Saturdays from 9 a. m. to 3 p. m., and from 4 to 4 30 p. m.

The Janitor, when not about the building, may be found at 111 W. Monument St.

HOURS FOR LECTURES AND RECITATIONS, FIRST HALF-YEAR, 1883-84.

Hours.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.	SATURDAY.
A. M.	General Chemistry. (Remsen.) Latin Prose. (Spieker.) Italian. (Todd.) Morphology. (Brooks.) Thermodynamics. (Rowland.) Analyt. Chemistry. (Morse.) French Philology. (Elliott.)	General Chemistry. (Remsen.) Livy. (Spieker.) Italian. (Todd.) Thermodynamics. (Rowland.) Analyt. Chemistry. (Morse.)	General Chemistry. (Remsen.) Livy. (Spieker.) Italian. (Todd.) Analyt. Chemistry. (Morse.)	General Chemistry. (Remsen.) Livy. (Spieker.) Spanish. (Todd.) Morphology. (Brooks.) Thermodynamics. (Rowland.) Analyt. Chemistry. (Morse.)	Physical Chemistry. (Remsen.) Livy. (Spieker.) Spanish. (Todd.) Thermodynamics. (Rowland.)	
9	Middle High German. (Dippold.)	New Test. Criticism. (Harris.) Logic. (Peirce.) Elem. Sanskrit. (Bloomfield.)	Homer. (C. D. Morris.) German Conversation.	New Test. Criticism. (Harris.) Middle High German. (Dippold.)	Logic. (Peirce.)	Mineralogy. (Williams.) German Conversation.
10	General Physics. (Hastings.) German: Major. (Dippold.) Physiology and Histol. (Martin.) Latin Prose. (Warren.) Latin Prose. (C. D. Morris.) Invariants. (Story.) Provençal. (Elliott.) Anglo-Saxon, Adv. (Wood.) Elocution. (Woodworth.)	General Physics. (Hastings.) German: Major. (Dippold.) Mammalian Anatomy. (Conn.) Greek Comp. (Gildersleeve.) Cicero and Pliny Letters. (Warren.) Lucretius. (C. D. Morris.) Anglo-Norman. (Elliott.) Mechanics. (Franklin.) Theoretical Dynamics. (Craig.) Elocution. (Woodworth.)	General Physics. (Hastings.) German: Major. (Dippold.) Physiol. and Histol. (Martin.) Latin: Read. at sight. (C.D.Morris.) Latin: Read. at sight. (Warren.) Invariants. (Story.) Old French. (Elliott.) Anglo-Saxon, Adv. (Wood.) Rig Veda. (Bloomfield.) Elocution. (Woodworth.)	General Physics. (Hastings.) Mammalian Anatomy. (Conn.) Aulus Gellius. (Warren.) Lucretius. (C. D. Morris.) Portuguese. (Elliott.) Mechanics. (Franklin.) Pali. (Bloomfield.) Theoretical Dynamics. (Craig.) Elocution. (Woodworth.)	General Physics. (Hastings.) German: Major. (Dippold.) Physiol. and Histology. (Martin.) Greek Comp. (Gildersleeve.) Cicero and Pliny Letters. (Warren.) Lucretius. (C. D. Morris.) Invariants. (Story.) Mechanics. (Franklin.) Elocution. (Woodworth.)	German Literature. (Lectures in German.) (Fortnightly.) Mineralogy. (Williams.) Çakuntala. (Bloomfield.)
11	General Biology. (Martin.) English: Minor. (Wood.) Greek Prose. (Spieker.) History: 2d year. (Adams.) Deter. and Theory of Equations. (Franklin.) Math. Theory of Sound. (Craig.) French Conversation. Elocution. (Woodworth.)	General Biology. (Martin.) German: Minor. (Dippold.) English: Minor. (Browne.) Lysias. (Spieker.) History: 2d year. (Adams.) Higher Plane Curves. (Story.) Latin Seminary. (Warren.) Spanish and Portuguese. (Elliott.) Total Diff. Equations. (Franklin.) French Conversation. Elocution. (Woodworth.)	Osteology. (Conn.) German: Minor. (Dippold.) English: Minor. (Wood.) Lysias. (Spieker.) History: 2d year. (Jameson.) Palæography. (Warren.) Romance Languages. (Elliott.) Deter. and Theory of Equations. (Franklin.) Math. Theory of Sound. (Craig.) Elocution. (Woodworth.)	General Biology. (Martin.) German: Minor. (Dippold.) English: Minor. (Browne.) Lysias. (Spieker.) History: 2d year. (Jameson.) Higher Plane Curves. (Story.) Ladinian. (Elliott.) Total Diff. Equations. (Franklin.) French Conversation. Elocution. (Woodworth.)	Osteology. (Conn.) German: Minor. (Dippold.) English: Minor. (Wood.) Lysias. (Spieker.) History: 2d year. (Jameson.) Latin Seminary. (Warren.) Deter. and Theory of Equations. (Franklin.) Math. Theory of Sound. (Craig.) French Conversation. Elocution. (Woodworth.)	Mineralogy. (Williams.) Çakuntala. (Bloomfield.) French Conversation.
M. 12	French: Minor. (Todd.) English: Major. (Wood.) Greek Prose. (C. D. Morris.) P. H. E. (Jameson.) International Law. (Adams.) Greek Seminary. (Gildersleeve.) Math. Astronomy. (Story.) Elocution. (Woodworth.)	French: Minor. (Todd.) English: Major. (Wood.) Thucydides. (C. D. Morris.) P. H. E. (Jameson.) International Law. (Adams.) Philosophical Sem. (G.S. Morris.) Elocution. (Woodworth.)	French: Minor. (Todd.) English: Major. (Wood.) Thucydides. (C. D. Morris.) P. H. E. (Browne.) International Law. (Adams.) Greek Seminary. (Gildersleeve.) Math. Astronomy. (Story.) Elocution. (Woodworth.)	French: Minor. (Todd.) Old Saxon. (Wood.) Thucydides. (C. D. Morris.) P. H. E. (Browne.) Am. Colonial History. (Adams.) Greek Historiog. (Gildersleeve.) Philosophical Sem. (G.S Morris.) Elocution. (Woodworth.)	French: Minor. (Todd.) English: Major. (Wood.) Thucydides. (C. D. Morris.) P. H. E. (Adams.) English Constitution. (Jameson.) Math. Astronomy. (Story.) Elem. Sanskrit. (Bloomfield.) Elocution. (Woodworth.)	Assyriological Exercises. (Haupt.)
P. M. 1	L. E. P. (Harris.) Polit. Econ.: Undergrad. (Ely.) Calculus. (Franklin.) Drawing. (Newell.) Elliptic Functions. (Craig.)	L. E. P. (Harris.) French: Major. (Todd.) Polit. Econ.: Undergrad. (Ely.) Conic Sections. (Story.) Drawing. (Newell.)	L. E. P. (Harris.) French Major. (Todd.) Polit. Econ: Undergrad. (Ely.) Calculus. (Franklin.) Elliptic Functions. (Craig.)	L. E. P. (Harris.) French: Major. (Todd) Polit. Econ.: Undergrad. (Ely.) Conic Sections. (Story.) Drawing. (Newell.)	L. E. P. (Harris.) French: Major. (Todd.) Polit. Econ.: Undergrad. (Ely.) Calculus. (Franklin.) Drawing. (Newell.) Elliptic Functions. (Craig.)	Assyriological Exercises. (Haupt.) Drawing. (Newell.)
2	Sumero-Accadian. (Haupt.) German. (Dippold.) (2.30 p. m.) Drawing. (Newell.)	Drawing. (Newell.)	Stilübungen. (Raddatz.) (2.30 p.m.) 2d Wednesday. German. (Dippold.) (2.30 p. m.) French Conversation.	German Prose: Major. (Raddatz.) (2.30 p. m.) German. (Dippold.) (2.30 p. m.) Drawing. (Newell.)	German Prose: Minor. (Raddatz.) (2.30 p. m.) Drawing. (Newell.)	Drawing. (Newell.)
3	Sumero-Accadian. (Haupt.) Drawing. (Newell.)	Assyrian. (Haupt.) Kaucika-Sutra. (Bloomfield.) Drawing. (Newell.)	Arabic. (Haupt.)	Assyrian. (Haupt.) Drawing. (Newell.)	Drawing. (Newell.)	Drawing. (Newell.)
4	Political Economy: Adv. (Ely.) German Philos. (G. S. Morris.) Mineralogy. (Williams.) Comp. Philology. (Bloomfield.) Drawing. (Newell.)	Multiple Algebra. (Sylvester.) Hist. of Philos. (G. S. Morris.) Hebrew. (Haupt.) Class. Antiquities. (Emerson.) Drawing. (Newell.)	Political Economy: Adv. (Ely.) German Philos. (G. S. Morris.) Ethiopic. (Haupt.) Mineralogy. (Williams.) German. (Gerber.)	Physics: Major. (Hastings.) Hist. of Philos. (G. S. Morris.) Hebrew. (Haupt.) Philos. Terminology. (Peirce.) Class. Antiquities. (Emerson.) Drawing. (Newell.)	Multiple Algebra. (Sylvester.) Political Economy: Adv. (Ely.) German Philos. (G. S. Morris.) Mineralogy. (Williams.) Assembly of matriculated students. Drawing. (Newell.)	Drawing. (Newell.)

The hour from 5 to 6 p. m. is reserved for public lectures, as announced from time to time.

November, 1883.

JOHNS HOPKINS UNIVERSITY CIRCULARS

Published with the approbation of the Board of Trustees

VOL. III.—No. 28.] BALTIMORE, JANUARY, 1884. [PRICE, 10 CENTS.

CALENDAR, 1883–84.

Tuesday, September 18.	Current Academic Year Began.
Tuesday, September 25.	Instructions Resumed.
December 22.—January 2.	Christmas Recess.
Friday, February 22.	Commemoration Day.
Friday, April 11.—Monday, April 14.	Spring Recess.
Friday, June 7.	Term of Instruction Closes.

CONTENTS.

The Johns Hopkins University Circulars are printed by Messrs. JOHN MURPHY & CO., 182 West Baltimore Street, Baltimore, from whom single copies may be obtained. They may also be procured, as soon as published, from Messrs. CUSHINGS & BAILEY, No. 262 West Baltimore Street, Baltimore.

STANDING ANNOUNCEMENTS.

JOHNS HOPKINS UNIVERSITY.

Opened for Instruction in 1876.

The Johns Hopkins University was founded by the munificence of a citizen of Baltimore, Johns Hopkins, who bequeathed the most of his large estate for the establishment of a University and a Hospital. It was intended that these institutions should coöperate in the promotion of medical education. The Hospital buildings are approaching completion.

The foundation of the University is a capital, in land and stocks, estimated in value at more than $3,000,000; the capital of the Hospital is not less in amount.

The University was incorporated under the laws of the State of Maryland, August 24, 1867. Power to confer degrees was granted by the Legislature in 1876.

Suitable buildings have been provided in Baltimore at the corner of Howard and Little Ross Sts., and are furnished with the necessary apparatus and books.

Academic Staff, 1883–4.

Daniel C. Gilman, ll. d., *President of the University.*
Basil L. Gildersleeve, ph. d., ll. d., *Professor of Greek.*
Paul Haupt, ph. d., *Professor of the Shemitic Languages.*
H. Newell Martin, dr. sc., a. m., *Professor of Biology and Director of the Biological Laboratory.*
Charles D. Morris, a. m., *Collegiate Professor of Latin and Greek.*
Ira Remsen, m. d., ph. d., *Professor of Chemistry and Director of the Chemical Laboratory.*
Henry A. Rowland, ph. d., *Professor of Physics and Director of the Physical Laboratory.*
J. J. Sylvester, f. r. s., d. c. l., *Professor of Mathematics.*
John S. Billings, m. d., *Lecturer on Municipal Hygiene.*
James Bryce, d. c. l., *Lecturer on Roman Law.*
J. Thacher Clarke, *Lecturer on Classical Archæology.*
Hiram Corson, a. m., ll. d., *Lecturer on English Literature.*
G. Stanley Hall, ph. d., *Lecturer on Psychology.*
J. Rendel Harris, a. m., *Lecturer on New Testament Greek.*
H. Von Holst, ph. d., *Lecturer on History.*
George S. Morris, a. m., ph. d., *Lecturer on the History of Philosophy.*
Charles S. Peirce, a. m., s. b., *Lecturer on Logic.*
Léonce Rabillon, bach. ès lett., *Lecturer on French Literature.*
William Trelease, s. b., *Lecturer on Botany.*
Herbert B. Adams, ph. d., *Associate Professor of History.*
Maurice Bloomfield, ph. d., *Associate Professor of Sanskrit.*
William K. Brooks, ph. d., *Associate Professor of Morphology and Director of the Chesapeake Zoölogical Laboratory.*
Thomas Craig, ph. d., *Associate Professor of Applied Mathematics.*
Charles S. Hastings, ph. d., *Associate Professor of Physics and Sub-Director of the Physical Laboratory.*
Harmon N. Morse, ph. d., *Associate Professor of Chemistry and Sub-Director of the Chemical Laboratory.*
William E. Story, ph. d., *Associate Professor of Mathematics.*
Minton Warren, ph. d., *Associate Professor of Latin.*
William Hand Browne, m. d., *Librarian and Examiner in English.*
A. Marshall Elliott, a. m., *Associate in Romance Languages.*
Richard T. Ely, ph. d., *Associate in Political Economy.*
Fabian Franklin, ph. d., *Associate in Mathematics.*
J. Franklin Jameson, ph. d., *Associate in History.*
Philip R. Uhler, *Associate in Natural History.*
George H. Williams, ph. d., *Associate in Mineralogy.*
Henry Wood, ph d., *Associate in English.*
Charles F. Raddatz, *Examiner in German.*
G. Theodore Dippold, ph. d., *Instructor in German.*
Edward M. Hartwell, m. d., ph. d., *Instructor in Physical Culture.*
Hugh Newell, *Instructor in Drawing.*
Henry A. Todd, a. b., *Instructor in Romance Languages.*
Charles L. Woodworth, jr., *Instructor in Elocution.*
Herbert W. Conn, a. b., *Assistant in Biology.*
H. H. Donaldson, a. b., *Assistant in Biology.*
Otto Lugger, *Assistant in Biology.*
Harry F. Reid, a. b., *Assistant in Physics.*
Edward H. Spieker, ph. d., *Assistant in Latin and Greek.*

PLAN OF THE CIRCULARS.

The Johns Hopkins University Circulars are published at convenient intervals during the academic year for the purpose of communicating intelligence to the various members of the University in respect to work which is here in progress, as well as for the purpose of promulgating official announcements from the governing and teaching bodies. During the current academic year, successive circulars may be expected in the months of January, February, March, April, May, and June, to be followed at the close of the year by an Index.

Although these circulars are designed for the members of the University, they have frequently been called for by institutions and libraries at a distance, and also by individuals who are interested in the literary and scientific activity of this University. Subscriptions and exchanges are therefore received.

TERMS OF SUBSCRIPTION.

For the current year, 1883–4, one dollar.

For the year 1882–3, (156 pp. in cloth covers), $2.

For the years 1880–2, (250 pp. in cloth covers), $5.

Subscribers to the Circulars will also receive the Annual Register and Report of the University.

All subscriptions should be addressed to the "Publication Agency of the Johns Hopkins University."

Communications for the Circulars should be sent in prior to the first day of the month in which they are expected to appear.

HOPKINS HALL LECTURES.

Notice in Respect to the Admission of the Public.

In answer to inquiries, and in correction of some current misapprehensions, the following statements are made in respect to these courses of lectures annually given in the Johns Hopkins University.

1. These courses are academic lectures, designed primarily for the members of the University, and supplementary to the regular class-room work of the students.

2. As the members of the University rarely require the entire room, the Trustees have taken great pleasure in inviting other persons, not connected with the University, to attend.

3. As these lectures are not intended for popular entertainment, but for the instruction of students, those persons first receive tickets, in most cases, who are known to be especially interested in a particular course,—ladies as well as gentlemen. Preference is thus given according to the character of the course, to teachers in other institutions, public and private; students of medicine, law, etc.; professional men and others. If any tickets remain undistributed, they are given out to those who may have applied for them, in order of application.

4. The hall is full when 200 hearers are present; it is uncomfortable if more are admitted. Not infrequently two or three times that number of persons apply for admission, and often applications for tickets cannot be granted. To give the lectures elsewhere would alter their character as a part of the ordinary academic work of the University.

5. *There is no general course ticket issued.* Applications should state specifically the course for which tickets are desired. Programmes and other current information pertinent to university work may be found in the *University Circulars*, sent to subscribers on the payment of one dollar per annum, either by Messrs. Cushings & Bailey, Messrs. John Murphy & Co., or the University.

The usage of giving personal notification is not likely to be continued, and those therefore who have been accustomed to receiving such announcements, should hereafter consult the *Circulars*.

6. It will save much delay if applications for tickets and inquiries on these and other routine matters are addressed not to individuals but to the Johns Hopkins University, *by postal card*, and answers will be promptly returned by mail. Personal applications consume time needlessly.

☞The lectures begin at 5 o'clock *punctually*. The doors of the hall are opened at fifteen minutes before 5, and the lectures do not exceed an hour in the delivery.

PUBLICATIONS ISSUED UNDER THE AUSPICES OF THE UNIVERSITY.

I. American Journal of Mathematics.

The publication of this journal commenced in 1878, under the editorial direction of Professor Sylvester. Five volumes of about 400 pages each have been issued, and the sixth is in progress. It appears quarterly, in the quarto form. Subscription $5 per year. Single numbers $1.50.

II. American Chemical Journal.

This journal was commenced in 1879, with Professor Remsen as editor. Five volumes of about 450 pages each have been issued, and the sixth is in progress. It appears bi-monthly. Subscription $3 per year. Single numbers 50 cts.

III. American Journal of Philology.

The publication of this journal commenced in 1880, under the editorial direction of Professor Gildersleeve. Three volumes of about 570 pages each have been issued, and the fourth is in progress. It appears four times yearly. Subscription $3 per volume. Single numbers $1.00.

IV. Studies from the Biological Laboratory.

[*Including the Chesapeake Zoological Laboratory.*]

The publication of these papers commenced in 1879, under the direction of Professor Martin, with the assistance of Dr. W. K. Brooks. Two volumes of about 500 pages, octavo, and 40 plates each, have been issued, and the third is in progress.

V. Studies in Historical and Political Science.

The publication of these papers was begun in 1882, under the editorial direction of Dr. H. B. Adams. The first volume of 470 pages is now completed, and the second is in progress. Subscription $3 per volume.

The following publications are also issued by the University:

The University Circulars. Subscription $1 per year.

The Annual Report presented by the President to the Board of Trustees reviewing the operations of the University during the past academic year.

The Annual Register giving the list of officers and students and stating the regulations of the University. Published at the close of the academic year.

The Journal of Physiology, edited by Professor Michael Foster, of Cambridge, England, is published with the aid of the Johns Hopkins University. Vol. IV., in progress. $5 per volume.

A volume of Contributions to Logic by members of this University was issued in 1882, under the editorial direction of Mr. C. S. Peirce. Price $2.00. Little, Brown & Co., Boston, Publishers.

The University Circulars, Annual Report, and Annual Register will be sent by mail for one dollar per annum.

All communications in respect to these publications should be addressed to the "Publication Agency of the Johns Hopkins University," Baltimore, Maryland.

Johns Hopkins University Circulars.

BALTIMORE, JANUARY, 1884.

CURRENT INTELLIGENCE.

The University Circulars are intended to include notes of progress in the work of the Johns Hopkins University as a whole, and in the several laboratories, seminaries, and associations which are directed by the principal teachers. They are not designed to be a magazine for long articles. The University contributes liberally to the maintenance of six journals devoted to the study of Mathematics, Chemistry, Biology, Physiology, Philology, and History—and there are many other publications in this country through which extended memoirs may reach the public. Under these circumstances it is deemed best by the authorities to reserve these pages for official announcements, and for concise statements respecting researches which have here been made in the different branches of science and literature. There is ample space for such communications.

Departure of Professor Sylvester.

Professor Sylvester, who has been the Professor of Mathematics in this University since its opening in 1876, has left Baltimore to take the chair of Savilian Professor of Geometry in the University of Oxford, to which he was elected December 5, 1883. A farewell assembly of gentlemen and ladies was held in Hopkins Hall December 20, when addresses were made by the President of the University, Judge Brown, Professor Gildersleeve, and Professor Sylvester. Among the guests were Mr. Matthew Arnold, Professor Newcomb, Professor Asaph Hall, Professor Hilgard, of Washington, Mr. Scudder, the Editor of *Science*, and other distinguished persons from a distance, besides a large number of the literary, scientific, and professional men of Baltimore. Before the addresses which pertained to the departure of Professor Sylvester, Mr. Matthew Arnold (who had at an earlier hour given a public lecture in the Academy of Music), was presented to the assembly, with a complimentary allusion to his former connection with the University of Oxford, and to the fact that Professor Sylvester had dedicated to him the "Laws of Verse," published in 1870. Mr. Arnold made a friendly response. Mr. Sylvester's remarks were full of pleasant allusions to his work at the Johns Hopkins, his esteem for his colleagues, and his good wishes for the foundation. The address was not written and occupied nearly an hour in delivery.

— On the afternoon of December 20, the academic staff of the University met in Hopkins Hall, by invitation of the President, and after a brief review by Dr. Story of the mathematical lectures here given from 1876 to 1883, and a like review by Dr. Craig of the contributions printed in the *American Journal of Mathematics*, Professor Gildersleeve read the following paper, which, on motion of Professor Rowland, was adopted by the meeting as an expression of their respect and good will.

"The teachers of the Johns Hopkins University, in bidding farewell to their illustrious colleague, Professor Sylvester, desire to give united expression to their appreciation of the eminent services he has rendered the University from the beginning of its actual work. To the new foundation he brought the assured renown of one of the great mathematical names of our day, and by his presence alone made Baltimore a great center of mathematical research.

"To the work of his own department he brought an energy and a devotion that have quickened and informed mathematical study not only in America, but all over the world; to the workers of the University, whether within his own field or without, the example of reverent love of truth and of knowledge for its own sake, the example of a life consecrated to the highest intellectual aims. To the presence, the work, the example of such a master as Professor Sylvester, the teachers of the Johns Hopkins University all owe, each in his own measure, guidance, help, inspiration, and in grateful recognition of all that he has done for them and through them for the University, they wish for him a long and happy continuance of his work in his native land; for themselves the power of transmitting to others that reverence for the ideal which he has done so much to make the dominant characteristic of this University."

— The Savilian Professorship of Geometry in the University of Oxford, was founded and endowed in the year 1619, by Sir Henry Savile, Knight, Warden of Merton College. The Professors may be chosen from any part of Christendom, provided they are persons of good character and repute, well skilled in mathematics, and twenty-six years of age; if Englishmen, they must be M. A., at the least. The following list gives the names of the holders of the Professorship since its foundation:

1619. Henry Briggs.	1766. John Smith.
1631. Peter Turner.	1797. Abram Robertson.
1649. John Wallis.	1810. Stephen Rigaud.
1704. Edmund Halley.	1827. Baden Powell.
1742. Nathaniel Bliss.	1861. Henry J. S. Smith.
1765. Joseph Betts.	1883. J. J. Sylvester.

(*From the Honors Register of the University of Oxford*, 1883).

The construction of a new building, in order to provide the members of the University with facilities for gymnastic exercises, was authorized by the Board of Trustees early in June last. Work in accordance with that vote was actively pushed forward from the middle of June until December 7, when the completed building, with its fittings and furniture, was opened to the public for inspection. The gymnasium has been planned to meet the requirements of 250 persons, and especial pains have been taken to secure an abundance of light and air in the main hall and in the dressing rooms connected with it. Until further notice it will be open to all members of the University from 9 a. m. till 9 p. m., daily, except Sunday.

Matriculate students will hereafter be required, in order to secure the degree of Bachelor of Arts, to take the course in Physical Culture. Announcements in detail concerning the nature and requirements of this course will be made at an early day.

The ground plan of the building in which the gymnasium and dressing rooms are contained resembles in shape a letter L turned thus ⌐. The main building of the ⌐ abutting on Garden street is 104 feet in length, includes the gymnasium proper and a vestibule, and the wing of the ⌐ extending from Garden street to the rear of Bentley Hall is nearly 85 feet in length. The entrance to the building is on Garden street at the junction of the main building and the wing of the ⌐. The entrance is through a vestibule, out of which, upon the first floor, doors open into the main hall and into the private dressing rooms, while on the second floor at the head of a flight of steps, is the door of the Director's rooms, in which the physical examinations are made and recorded. The vestibule and gymnasium hall are in the new building; while the dressing and bath rooms, and the offices of the Director are in the wing.

The main hall comprises a single room, open to the roof, and has a total height from floor to ridge pole of 48 feet. It has upwards of 3400 square feet of flooring; its walls, of painted brick, are 25 feet high and 18 inches thick; and each of its side walls contains 7 high and wide windows whose sills are seven feet from the floor.

A very complete set of Dr. Sargent's developing appliances is ranged against the walls on the four sides of the room, and a variety of apparatus such as is usually found in gymnasiums has also been provided.

In the dressing rooms a large number of private lockers are placed, besides bath tubs and set bowls supplied with hot and cold water.

The gymnasium is a place for "body-building" and a place for recreation. It will be administered as far as possible in accordance with the plan followed by Dr. Sargent (in the Hemenway Gymnasium of Harvard University). The purpose is to give to each individual guidance and counsel based upon and determined by a careful examination of his *physique*. It is held that the end and aim of physical training is to enable the body to do with pleasure and ease all the work of which as a mechanism it is capable.

E. M. H.

The principle referring the inception of phonetic change to alterations in the physiological alphabet, separates too widely such cases as might possibly fall under it, namely, where sounds entirely disappear from a language, or suffer, in all words, some alteration in mouth position, from all the other, (much more numerous) phonetic differences between cognate dialects, *e. g.*, the changes under Grimm's Law, where a proethnic *t* becomes *d*, in certain English words, although *t* still remains in the language. Compare also the laws of finals.

Nor does the simple theory of economy of muscular action fully explain such cases, as is very well known. Perhaps most purely phonetic change may also be referred to the analogy of other words in the language, already containing the new combinations of sounds; thus the inorganic ϑ in ἀνϑρωπος may be simply the result of the reminiscence of organic-νϑρ-elsewhere. From this point of view, the inception of new phonetic law may seem a little less mysterious, and additional theoretical reasons found, in virtue of which we may assume it to be probable that complete uniformity will not be attained; all analogy action is confessedly irregular.

If, however, it be once admitted that a language may present inconsistent phonetic phenomena, it follows that the reconstruction of mother tongues, and particularly of intermediate mother tongues (general Germanic, general Low German, &c.) is a very uncertain process, because a phonetic law of very limited range may extend itself and become the prevailing law in a group of derived cognate tongues. And, conversely, the deduction of a special form from one existing or hypothetical parent form, with irregularities attributable only to later borrowing, analogy, etc. is correspondingly liable to error. This is true of the relation of the Indo-European family of languages to the primitive tongue.

On the Probability of the Existence of Phonetic Law.

By M. Bloomfield.

[Abstract of a paper read at a meeting of the University Philological Association, March 7, 1884].

The belief in the existence of inviolable phonetic law which according to the extremest view acts like a law of nature cannot at present be freed from the charge of dogmatism (cf. Whitney, Proc. Am. Phil. Ass., 1882, p. xviii; Fr. Müller, Techmer's Zeitschrift für Sprachwissenschaft, I, p. 213). Phonetic action, whatever its cause may be, is crossed by analogy, another powerful factor in linguistic change, which certainly does not act with sufficient regularity to enable us to point out its exact extent, to eliminate it from our count, and to leave a clean balance of phonetic action. It is only by a sense of linguistic taste or tact, qualities confessedly subjective, that the doings of analogy can be scanned; there is nothing inductive about this. Every accepted explanation through analogy is accepted only in so far as the prevailing opinion of the best grammarians holds that the deviation from the path of phonetic law has been thus and thus and not some other way. Moreover the words 'inviolable' or 'infallible' in matters of grammar are always to be deprecated, because the conscious will of the language user certainly stands above phonetic facts. We ought rather to speak of the regularity of phonetic courses, which are never left without some positive causes for deviation.

Though the doctrine of phonetic law even in this modified form is a dogma which will never be proved inductively, it can nevertheless be invested with a satisfactory degree of probability. The following are the arguments:

1. No other known theory succeeds in any way in satisfactorily explaining the origin of regular phonetic change on a large scale. There is no point in Whitney's discussions of language which provides satisfactorily for this phenomenon. In two passages of his 'Language and the study of Language' (pp. 95 and 152) he confesses himself unable to account clearly for the most prominent phonetic peculiarities of individual languages, and whatever suggestion these passages do contain is in accord with the theory of phonetic law. Prof. Easton's suggestion (*see above*) that 'perhaps most purely phonetic change may also be referred to the analogy of other words in the language, already containing the new combinations of sounds' ignores the fact that certain changes and developments of sounds must be phonetic and not analogical because they are of frequent or universal occurrence in widely different languages; furthermore, the regularity of certain phonetic facts (as *e. g.* Grimm's law when supplemented by Verner's) is in no way disposed of by this assumption. Neither are we likely to be satisfied by Frdr. Müller's parallel between phonetic law and fashion (loc. cit.)

2. Our judgment as to the intrinsic probability of the theory depends upon the extent and the character of the ground which it would cover in the case of its general acceptance. If it be framed to cover a few cases of small scope it falls from its own weakness. If on the other hand it accounts for just those parts of the language-body and language-history which are most scrutable and exposed, and if these form a sufficiently respectable share of the entire mass of the language facts this hypothesis like all others thereby itself becomes a probability. Two facts which show the latter to be true must be borne in mind here. First, there is no language which can be studied historically or comparatively that does not exhibit phonetic facts of sufficiently wide scope to allow us to apply to them the term phonetic law. Secondly, the more incisive the study of any group of languages becomes, the larger grows the number of phonetic laws. On the other hand, it would be impossible to exhibit any language where the phonetic changes either within its own special history or when compared with its kin are exclusively sporadic or arbitrary. Yet nothing would be more natural than just this state of things, providing that nothing but the semi-conscious whim of the individual, aided by his linguistic pet-vice of laziness, originally lay at the bottom of every phonetic change.

3. In the manner in which the principle of phonetic law has accomplished work lies the strongest proof of its reality and its surest hold upon linguistic science. It is obviously beyond the scope of an abstract to point this out, as it would involve a short history of Indo-European, and to some extent Shemitic, grammar within the last few years. It is not too much to say that if the doctrine of the inviolableness of phonetic law should ultimately turn out to be false that this fact would not detract very much from its methodological value; there it has approved itself by its fruits.

The Nahuatl-Spanish Dialect of Nicaragua.

By A. M. Elliott.

[Abstract of a paper read at a meeting of the University Philological Association, March 7, 1884].

The text on which this investigation is based constitutes No. III in the series of Dr. D. G. Brinton's "Library of Aboriginal American Literature" and is published under the title of "The Güegüence, a Comedy Ballet in the Nahuatl-Spanish Dialect of Nicaragua." It is printed from a collation of two MSS. made by Dr. Berendt in 1874, no part of which has ever before been translated. Both the age and authorship are unknown. With reference to the former the able editor thinks we may assign the early portion of the eighteenth century as the latest date for its composition, and there is some evidence that a more remote period is not improbable.

The language represents a *mischdialekt* composed of Nahuatl and Spanish elements, the latter bearing the stamp of the home idiom when it was brought into contact with the aboriginal tongue at the beginning of the sixteenth century, through the conquest of Mexico by the Spaniards. The formal conquest of Nicaragua took place in 1522, when it was attached to the Captain Generalcy (*Audiencia*) of Guatamala, under which rule it remained till the outbreak of the revolution in 1821, thus making three hundred years of steady, uninterrupted Spanish dominion. The Europeans found in Central America the same extraordinary idiom, the Aztec, Nahuatl, or Mexican, which they had learned to know on the vast plain of Anáhuac. This was a language not only of wonderful copiousness and flexibility, but also an extremely polysynthetic speech in which the process of agglutination has the greatest sweep. The linguistic tendencies were thus directly opposed here to the strong analytic development of the Neo-Latin language with which the native idiom was brought into contact by the conquest of Mexico.

In sifting the material of this compound product, the resultant of a mixture of two contrary lines of language growth, we must take as our basis the classical Spanish of the time of Cervantes, born just a quarter of a century after the occupation of Nicaragua, with its now obsolete grammar forms and antiquated constructions, and to this add the varying dialect influences which must have been brought to bear on the new product by the common speech of the Spanish soldiers.

If we begin with the vowel system, we find the most common differences that separate the Nahuatl from the classic Spanish and bind it with the old and dialect form of the same, to be: $e = i$, $o = e$, $o = a$. For example, *Velancicos* (*Sp. villancicos*), *seno*, (*Sp. sin*) where the *i*, both tonic and atonic,

has been strengthened and raised a point in the scale of phonic production. This is a special trait of the Old and Folk's language in Spain. The same tendency to raise the weak vowels we find illustrated in the Old Latin by the vacillation between *e* and *i* in such forms as *tempestatebus, mereto* compared with the classic *tempestatibus, merito*. In the Spanish Folk speech it was the *e*-form that was kept, and especially at this period of the language pretonic *i* was constantly represented by *e*, as in *Cecilia* (for *Cicilia*), *dejiste* (for *dijiste*), etc. Again, the more common raising of the vowel power from *e* to *a* is in accordance with the usual Spanish dialect influence *e. g. Amilio Castalar* (for *Emilio Castelar*), *Ajercito* (for *Ejercito*), used by the Folk in Castile, and is especially marked in the moulding of Nahuatl forms to suit the requirements of Spanish flexion or to satisfy the demands of Spanish euphony.

In *seno* = O. Sp. *sines, senes*, we have *e* = *o* just as in the modern *obispo* (*Episcopus*) or the Old Spanish *romanecer* (Mod. Sp. *remanecer*).

For the consonantal system we find, for the most part, certain classes only affected, namely, the gutturals and sibilants. In the first title itself of the *Baile* we have the aspirated Nahuatl *h* of *huehue*, "old man," passing regularly into the medial guttural, similar to the transference of the Gothic *h* from Teutonic to certain parts of the Romance soil. The lowering of the vowel *u* to *ü*, together with this gutturalization of initial *h*, is a mode of dealing with the initial *hu* that is found in various districts of the Spanish peninsula, but it is especially the Asturian who always says *güertu, güeso* for Castilian *huerto, hueso*, etc.

In the Cuban dialect there is no difference in the pronunciation of the graphic signs *c, z, s*, all of them being the simple sibilant *s*. So, too, *x* and *s* interchange in the Nahuatl-Spanish *e. g. Silguerio* (for Span. *Xilguero*). This *x* at the time of the conquest of Mexico was = English *sh* or Arabic ش, and hence its origin as the notation of an unknown quantity. Arabic شَيْ (šai) "thing" (= Italian *Cosa*), used for this purpose, was reduced to simple ش = *x*.*

In its morphology the Nahuatl-Spanish separates itself more clearly from the modern language than in its phonology. The Mexican has had little influence here so far as the individual word is concerned. In the nomen-series old Spanish forms with special dialect influence are the chief factors that constitute the difference between the new mixture and the Castilian of to-day.

But it is especially in the verb that we note the most striking characteristics both of a stage of language older than the present Castilian and of the extensive play of dialect power.

The most interesting peculiarity of the verb formation is seen in the future tense, which is built up almost exclusively in the regular periphrastic manner of the Romance languages, save that the component elements are not welded together, that is, the auxiliary is kept distinct from the infinitive by the relational *de*, so that we have *ha de hablar, ha de ser*, etc. It is thus we have the special idiomatic futures that represent "duty, intention, design, possible possession," passing over sometimes into a state of verbal action which does not bear these special significations. There are only a very few infinitival types in this whole play where the parts are bound together into a single whole, and these simply serve to denote indefinite future conditions without any limitations whatever.

In the new word-building of this dialect we find the same modes of procedure which come up in the adaptation of Teutonic roots to Romance uses. But with all the changes of both phonology and morphology we do not have the dialect character of the "Güegüence" so well established as in its syntax. It is here especially that we find the extended influence in certain cases of the native idiom and again witness more directly than any where else the strong drift towards a strictly agglutinated form of language in which all flexion has disappeared and where nothing but the context serves us in trying to discover the thought of the writer.

This paper will be found in full in the forthcoming number of the *American Journal of Philology*.

*Cf. Paul de Lagarde: Woher stammt das *x* der mathemateker? Gött. gel. Anz., 1883, No. 13. Prof. Paul Haupt was so kind as to call my attention specially to this article.

On the Angelology of Hermas. By J. RENDEL HARRIS.

There is a passage in the Shepherd of Hermas, Vis. iv, 2, 4, which has occasioned a great deal of perplexity to the commentators. Hermas is met by a fierce beast with a parti-colored head, which beast symbolizes an impending persecution or tribulation, and makes as though it would devour him. But the Lord sends his angel who is over the wild beasts, whose name is Thegri, and shuts the mouth of the creature, that it may not hurt him. *θεγρί* according to Gebhardt and Harnack is 'nomen inauditum'; it appears in the Vulgate Latin as *Hegrin*, and in the Palatine version as *Tegri*. The Ethiopic translation has Têgêri. Jerome seems to have read *Tyri* since in his comments on Habac., 1, 14, we have "ex quo liber ille apocryphus stultitiæ condemnandus est, in quo scriptum est quemdam angelum nomine Tyri præesse reptilibus." Much ingenuity has been expended over the origin of the word and in particular the following is the solution of Franciscus Delitzsch, as given in Gebhardt and Harnack's edition: "Si sumi possit, Hermam nomen angeli illius ex angelologia Iudaica hausisse, quæ angelos maris, pluviæ, grandinis, etc., finxit iisque nomina commentitia indidit, *θεγρί* idem est quod תַּגְרִי(הַתַּגְרִי) *instimulator*, h. e. angelus, qui bestias (contra homines) instimulat atque, si velit, etiam domat (Taggar = dissidium, discordia; cum ṯ = Tigrî, quod bene transcripsit H.: *θεγρί*), etc."

I assent to the Hebrew origin of the name, but am unwilling to explain a 'nomen inauditum' by a 'nomen vix auditum.' A more simple solution suggests itself; if for *θ* we write *σ*, according to the confusion common in uncial script, we have *Σεγρί* for the name of the angel; which immediately suggests the root סָגַר, to close. The angel is the one that *closes* or *shuts*. This is immediately confirmed by the language of Hermas, *ὁ κύριος ἀπέστειλεν τὸν ἄγγελον αὐτοῦ τὸν ἐπὶ τῶν θηρίων ὄντα, οὗ τὸ ὄνομά ἐστιν θεγρί, καὶ ἐνέφραξεν τὸ στόμα αὐτοῦ ἵνα μή σε λυμάνῃ.*

If any doubt remained as to the correctness of this solution it would be swept away by reading the passage in Hermas side by side with the LXX of Dan., vi, 23: *ὁ θεός μου ἀπέστειλεν τὸν ἄγγελον αὐτοῦ καὶ ἐνέφραξεν* (וַיַּסְגֵּר) *τὰ στόματα τῶν λεόντων καὶ οὐκ ἐλυμήναντό με.*

The curious parallelism of the language employed in the two passages is decisive as to the etymology, and further we may be sure that the language of Hermas is an indirect quotation from the book of Daniel.

The result arrived at is an important one in many respects, and has a possible bearing upon the genealogy of the MSS. and versions of Hermas; so far as we are concerned we may simply say that those copies and versions which read *θεγρί* or any variation of the same bear conclusive marks of a Greek original. It might seem unnecessary to make such a remark, but the fact is that grave suspicions have been thrown out in some quarters as to the character of the original text of Hermas. Upon further consideration I am inclined indeed to conclude that all the versions came from an original copy which read *θεγρί*, for even the Vulgate Latin which has *Hegrin* seems to have arrived at it by dropping the reduplicated T in the words NOMEN ESTTHEGRI. There is however, another way in which the Latin variant might be explained; for, as Dr. Haupt points out to me, we have a similar transformation in the Hebrew סְפַרְוַיִם (2 Kings, xviii, 34), which appears in Berosus as *Σίσπαρα*, in Ptolemy v. 18 *Σίπφαρα*, but in Pliny vi. 123 as *Hipparenum*.

Historical sketch of Syriac Literature and Culture. By A. L. FROTHINGHAM, JR.

[Abstract of two papers read before the Society for the study of Shemitic Philology. January 13 and February 28].

The Syriac language is of especial importance from the position which it took at the time of two great religious revolutions: the conversion of the East to Christianity and the rise of Mohammedanism. In the first case it became the sacred language of the converted Eastern peoples, and in the second it was the means of communicating Greek culture to the Arabs.

During the early period of Christianity Syriac came into general use among the converts of Armenia, Persia, Arabia, and was even propagated by colonies to Hindustan and China. This universal use was facilitated by the fact that versions into Syriac of nearly all the works of the Greek Fathers were made at early dates: in fact many of their important writings have been preserved only in Syriac, *e. g.* Melito, Ambrose, Hippolytus, Theophania and Martyrs of Palestine of Eusebius, Festal Letters of Athanasius, &c.

The earliest work of importance is the version of the Bible called *Peshitta*, probably made at the beginning of the second century. Bardesanes and his son Harmonius, and Tatian the Assyrian are important writers of this century, and in the following, Mani wrote mostly in Syriac, as we know from many Eastern and Western authorities.

The fourth century was the golden age of the literature, when the language obtained a settled standard of taste, especially under the influence of the numerous writings of Ephraem.

An impulse to literature and learning was given by the Nestorian controversy in the fifth century which heresy was so vigorously supported by the famous "School of the Persians" at Edessa, that it was closed by orders of the Emperor Zeno (489) and its professors transferred their *penates* to Nisibis and Seleucia in the Persian Empire.

Connected with Nestorianism was the influence that Greek learning began to acquire over Syria, which led to the close study of the best writings of antiquity, favored by the leaders of the schools or universities. These universities had a great influence, not yet sufficiently appreciated, on the tendencies of the age; they were numerous and existed not only in the cities but attached to the principal monasteries. Their privileges were great and they were generally quite independent. The most noted were those of Edessa, of Nisibis for theology, and of Gandisapur for medicine: the great majority provided for a general liberal education. It is recorded that the students at Nisibis under Hanan (sixth century) numbered fully 800.

The sixth century was a period of great literary activity: the most prominent writers were James of Sarug and Philoxenus of Hierapolis, both belonging to the Monophysite sect. Now, for the first time, was attention given to the writing of history. Material was at hand in the precious archives of Edessa which existed from the beginning of the Christian era: some use was made of the documents there preserved by the anonymous Chronicle of Edessa (c. 540). The histories of Zacharias Rhetor and John of Asia are of value, especially for Eastern history.

An abrupt change was brought about by the Mohammedan invasion, which, although it by no means put an end to the literary activity of Syria, yet strongly influenced its development by the gradual extinction of the Syriac language among the people. The influence of Arabic began to be felt almost immediately after the conquest, although, of course, first in administrative and commercial centres.

In order to guarantee the purity of Syriac, the school of purists founded by Jacob of Edessa (710) found it necessary to establish a standard of taste and to express by written signs the mechanism of vowel pronunciation, until then left unexpressed. This movement was accompanied by an increase of Greek influence; and the combination of this with the gradual inroads of Arabic soon marred the idiomatic beauties of the language.

The Syrians had already become divided into two great camps, the Nestorian and the Monophysite or Jacobite, and each had its great centres of education and special literature. The influence of the Nestorians was greater, especially with the Arabs.

At this time many schools are founded by Syrians at Bagdad, and to these the Arabs flocked to learn the wisdom of the Greeks. From the eighth to the tenth century the Christian Syrians are the acknowledged masters of the Arabs: many like Honain, Isaac, John bar Mesue, &c., obtain fame by translating the Greek standard works on philosophy, medicine, mathematics, astronomy, geography, mechanics, &c. The Khalifs of the dynasty of the Abbassidae gloried in their munificent patronage of Syrian learning: the royal physician was invariably a Syrian, also the royal treasurer and other officers, and even governors of cities and provinces.

While Syriac literature declined in taste it acquired more scientific tendencies. Philosophy became one of the principal studies: that of Aristotle was mainly followed and many commentaries were made of his writings. Grammar and lexicography also began to receive considerable attention, and at first Greek and later Arabic models were followed. Historical studies also assumed more importance: Jacob of Edessa, Dionysius of Tellmahre (c. 775), Thomas of Marga (IX), Michael the Great (1090), and Gregory Bar'ebraia (XIII), form a long chain of writers on history who are recognized as of standard value.

Since the tenth century Syriac learning had fallen very low: in the thirteenth the Patriarch Bar'ebraia made an attempt to restore life to it, but even his scholarly genius, though embracing all branches of learning, did not succeed.

T. L. Beddoes, a Survival in Style. By Henry Wood.

[Abstract of a paper read at a meeting of the University Philological Association, November 2, 1883].

The man and his writings are so nearly forgotten, and copies of his works so scarce, that the article gives a few particulars of his life as an introduction. These serve also to explain in part the fact that Beddoes' writings, in spite of the laudatory reviews which even the earliest of them forced from every critic who took the trouble to read them, never really impressed his own age, and have been regarded as lying outside the range of English dramatic literature, the productions of "a strayed singer." The article is not further concerned with the faultiness of this traditional literary estimate of Beddoes, which sufficiently appears in the course of the investigation. Its object is to show that the style of Beddoes' writings (aside from certain peculiarities) is in the national and historical sense thoroughly English: a remarkable example of the survival of the main characteristics of such a style, in undiminished vigor, in the nineteenth century. For convenience of comparison, the Anglo-Saxon epic poetry and Shakspeare are taken as representing the two most important periods, and the similarity of Beddoes' style is shown in detail. The question of constructive power, or of the general canons of style is not entered upon, the comparison being mainly one of figures of speech. It is not assumed that Beddoes completely represents his own age. But on the other hand, his own letters and the character of his works prove him to be no imitator nor Shakspeare reviver, his vocabulary and constructions are thoroughly modern, and he profoundly admires three modern poets, Shelley, Wordsworth, and Keats. The comparison of Beddoes' style, or of any strong English style, with the intensely subjective Anglo-Saxon epic-lyric style has its difficulties, but it is plain that the prime characteristics of the A. S. metaphor recur in a marked degree in Shakspeare's and Beddoes' use of that figure, while the two latter agree surprisingly in their handling of the simile, which the A. S. scarcely used. An extended list of epithets, or kennings, is given from Beddoes, and with them are compared similar ones from Shakspeare, the A. S. Genesis, Exodus, Béowulf, and from Old Norse. A very close coincidence is revealed, and in many instances both Shakspeare and Beddoes are found to be as Anglo-Saxon as are the Anglo-Saxons themselves, in regard to the nature and scope of their epithets.

The article of which the foregoing is an abstract is published in full in the *American Journal of Philology*, Vol. 4, No. 16.

The concluding part, treating of fully expressed metaphors, similes, etc., will appear in Vol. 5, No. 18.

MATHEMATICS.

A Note on Partitions. By G. S. Ely.

[Abstract of a paper read at a meeting of the University Mathematical Society, March 19, 1884].

From the partitions of any number, n, can be formed the partitions of $n+1$, by the addition of a unit to each of the parts of each of the partitions of n, which is less than the previous part. Thus, for example, from the partition of 10, . . . 5, 2, 2, 1, can be generated the following partitions of 11 —

6, 2, 2, 1; 5, 3, 2, 1; 5, 2, 2, 2; 5, 2, 2, 1, 1.

Then it is evident that any partition of n, will, in this way, generate as many partitions of $n+1$, as there are parts of different values in the given partition of n, plus one: and that any given partition of $n+1$, will be generated from the partitions of n, as many times as there are parts of different values in the given partition of $n+1$. It is furthermore evident that if two partitions of n are conjugate, the partitions of $n+1$, which are generated from them, will be conjugate.

If the total number of partitions of n be of parity opposite to the total number of partitions of $n+1$, then there has been a gain in the number of self-conjugate partitions of $n+1$, over that of n, provided that n is greater than one. Passing from 1 to 2 there is evidently a loss in the number of s. c. p. (= self-conjugate partitions). But in any other case than $n=1$, let us consider a s. c. p. of n. The point at the end of the principal diagonal and the points immediately adjacent to it must have one of the two forms:

where the dotted line is the principal diagonal. In the first case we can place an extra point at the end of the diagonal and thus generate a s. c. p. of $n+1$. In the second case we may place an extra point at the end of the first line and remove the point from the end of the diagonal and place it at the bottom of the first column: and thus generate a s. c. p. of $n+1$. Thus it is evident that every s. c. p. of n may be used to generate a s. c. p. of $n+1$, and from the manner of generation it is evident that different s. c. p.'s of n will generate different s. c. p.'s of $n+1$. Thus the two s. c. p.'s of 8 are

which generate the s. c. p.'s of 9,

Therefore the number of s. c. p.'s of $n+1$ cannot be less than the number of s. c. p.'s of n $(n>1)$. Therefore when the parity of the whole number of partitions changes in passing from n to $n+1$, there is a gain in the number of s. c. p.'s $(n>1)$. And in such a case the gain must be a gain of an odd number of s. c. p.'s. It is of course possible that there should be a gain in the number of s. c. p.'s in passing from n to $n+1$ where the parity does not change, but such a gain must be a gain of an even number of s. c. p.'s. For example, in passing from 23 to 24 the parity does not change, but there is a gain of two s. c. p.'s, *i. e.*, from 9 to 11.

If we examine Euler's table we see that the parity of the whole number of partitions changes in passing from 2 to 3, from 7 to 8, from 11 to 12, from 14 to 15, from 16 to 17, from 18 to 19, from 19 to 20, etc. Hence as 2 has no s. c. p., the numbers from 3 to 7 inclusive must have at least one s. c. p. each; from 8 to 11 at least two each; from 12 to 14 at least three each; 15 and 16 at least four each; 17 and 18 at least five each; 19 at least six and 20 at least seven. Constructing the s. c. p.'s by the method which Dr. Durfee has given we find that 20 has just seven s. c. p.'s. Hence the numbers from 2 to 20 have just the number of s. c. p.'s which has been given.

Unicursal Curves of Degree $n+1$ in n-flat Space. By G. BISSING.

[Abstract of a paper read at a meeting of the University Mathematical Society, March 19, 1884].

The relation connecting the parameters of the points of intersection of a plane unicursal cubic and a right line is known. Taking then, by analogy, the unicursal curve of degree $n+1$ in n-flat space,

$$\theta x_j = a_{j,1}u^{n+1} + a_{j,2}u^{n+2} + \dots a_{j,n+2} \quad (j = 1, 2 \dots n+1),$$

we wish to find the k conditions that $n+2-k$ of its points, say $u_1, u_2 \dots u_{n+2-k}$, should lie in an $n-k$ flat; $(k = 1, 2 \dots n)$.

I define $A_1, A_2 \dots A_{n+2}$ as the determinants of order $n+1$ obtained by omitting respectively the first, second $\dots n+2$d column from the matrix of the coefficient of the above system of $n+1$ equations, and $(u_j)_l$ as the sums of the homogeneous products of $u_1, u_2 \dots u_j \dots u_l$ taken j at a time. The k conditions are then

$$A_1 + A_2(u_1)_{n+2-k} + A_3(u_2)_{n+2-k} + \dots A_{n+3-k}(u_{n+2-k})_{n+2-k} = 0,$$
$$A_2 + A_3(u_1)_{n+2-k} + A_4(u_2)_{n+2-k} + \dots A_{n+4-k}(u_{n+2-k})_{n+2-k} = 0,$$
$$\dots\dots\dots$$
$$A_k + A_{k+1}(u_1)_{n+2-k} + \dots\dots\dots A_{n+2}(u_{n+2-k})_{n+2-k} = 0.$$

To prove this for $k=1$, take as the equation of the $n-1$ flat,

$$l_1x_1 + l_2x_2 + \dots l_{n+1}x_{n+1} = 0.$$

Substituting herein for the x's their values in terms of u, we get

$$u_{n+1}\sum_1^{n+1} l_ja_{j,1} + u_n \sum_1^{n+1} l_ja_{j,2} + \dots \sum_1^{n+1} l_ja_{j,n+2} = 0.$$

From this we obtain at once by definition of $(a_j)_l$,

$$(u_1)_{n+1} = -\frac{\Sigma l_ja_{j,2}}{\Sigma l_ja_{j,1}},$$
$$(u_2)_{n+1} = \frac{\Sigma l_ja_{j,3}}{\Sigma l_ja_{j,1}},$$
$$\dots\dots$$
$$(u_{n+1})_{n+1} = (-)^{n+1}\frac{\Sigma l_ja_{j,n+2}}{\Sigma l_ja_{j,1}}.$$

Now it is evident that we shall obtain the desired relation between the u's by eliminating the l's from this system of equations. The equations being linear in the l's the eliminant is a determinant which, upon interchanging rows and columns, may be written

$$\begin{vmatrix} a_{12}+a_{11}(u_1) & a_{31}-a_{11}(u_2) \dots a_{1,n+2} \pm a_{11}(u_{n+1}) \\ a_{22}+a_{21}(u_1) & a_{32}-a_{21}(u_2) \dots a_{2,n+2} \pm a_{21}(u_{n+1}) \\ a_{32}+a_{31}(u_1) & a_{33}-a_{31}(u_2) \dots a_{3,n+2} \pm a_{31}(u_{n+1}) \\ \dots & \dots \\ & (n+1) \text{ rows} \end{vmatrix} = 0,$$

where the bracketed u's are to have the suffix $n+1$ attached. This determinant, however, evidently reduces to

$$A_1 + A_2(u_1)_{n+1} + A_3(u_2)_{n+1} + \dots A_{n+2}(u_{n+1})_{n+1} = 0,$$

which is then the relation connecting the parameters of any $n+1$ points which lie in an $n-1$ flat.

Solving this equation for u_{n+1} we get

$$-[A_2 + A_3(u_1)_n + A_4(u_2)_n + \dots A_{n+2}(u_n)_n]u_{n+1} = A_1 + A_2(u_1)_n + A_3(u_2)_n + \dots A_{n+1}(u_n)_n.$$

Now, in general, n points determine an $n-1$ flat, and therefore for a definite system of values of $u_1, u_2 \dots u_n$ we get a definite value of u_{n+1}. If, however, these n points lie in an $n-1$ flat, there are an infinity of $n-1$ flats passing through them which therefore cut the curve in an infinity of points, and we can have no definite value of u_{n+1}. The two conditions that the n points $u_1, u_2 \dots u_n$ should lie in an $n-1$ flat are, therefore,

$$A_1 + A_2(u_1)_n + \dots A_{n+1}(u_n)_n = 0,$$
$$A_2 + A_3(u_1)_n + \dots A_{n+2}(u_n)_n = 0.$$

And so on in general.

I add that Mr. E. Weyr has obtained these relations for the case $n=3$.

HISTORY.

Additional Notes on Icaria. By ALBERT SHAW.

[Abstract of a paper read before the Seminary of Historical and Political Science, March 21, 1884].

In the *University Circular* for November, 1883, the writer gave an abstract of a paper on the career of Étienne Cabet, the French communist, and the founding of the Icarian Community, the history of which was traced from its disastrous experience in Texas and its brief residence in New Orleans, through the period of its successful existence at Nauvoo, Illinois, to the quarrel and division of the community, and the unhappy death of Cabet in St. Louis in 1856. The present paper continues the story of Icaria from 1856 to 1884. The minority, 180 in number, who had followed Cabet from Nauvoo to St. Louis only a week before their leader's death, were left in sorry straits; but they resolved unanimously to persevere in their enterprise and remain together. They purchased an estate called Cheltenham, in the suburbs of the city, and were known as the "Cheltenham Community." Their men were tailors and shoemakers, and worked in the city. The Community was weakened by a disagreement between those wishing a democratic and those wishing a dictatorial government. The civil war gave the finishing blow, and Cheltenham ceased to be.

The majority, who had remained at Nauvoo, were left with embarrassed finances; and the panic of 1857 forced them to make an assignment of their property. They retained, however, a tract of land in Adams county, southwestern Iowa, whither they removed, depleted in numbers and crushed by debt. Up to 1876 their story is a monotonous record of hardship, perseverance, and gradual recuperation. In 1877 they were on a sound material basis and their prospects seemed flattering in every way. Just at this time, however, the Community was entering upon the crisis inevitably involved in transferring the enterprise to the hands of a second generation. There arose two parties, the old party, or conservatives, and the young, or liberal party. The latter advocated more vigorous propaganda and a freer policy in the matter of admissions. The difference had been accentuated by the arrival of a number of French Internationalists, most of whom had been active participants in the Paris Commune of 1871 and all but one of whom joined the young party. Amicable adjustment failing, the young party carried the strife into the courts and succeeded in obtaining a nullification of the charter of incorporation, on technical grounds. The estate (of nearly 2,000 acres) was divided between the parties and they re-organized into two

autonomous communes, the young party securing the name "Icarian Community" and the old party adopting the title "New Icarian Community." The paper proceeded to describe the industrial organization and social life of the two communities as seen by the writer on visits paid in May and October, 1883. The community of the old people is small in numbers and does not give great promise of growth.

Several members left the young party about 1880 and went to Cloverdale, Sonoma Co., California (near San Francisco), where they purchased a fruit farm and arranged for the development of a large communistic society on Icarian principles. The remaining members of the Iowa party of the young people have now formed a contract of union with the California Icarians, and are about moving thither. This new colony bears the name "Icaria-Speranza," the latter name being added in honor of the distinguished socialist and philosopher Pierre Leroux, who wrote a sketch of an ideal society which he entitled "Speranza," and whose nephews formed the nucleus of the California colony. Fruit-growing seems a business peculiarly well adapted to a communistic society of Gallic origin, and the future history of "Icaria-Speranza" will be awaited with interest. The remaining portion of the paper contained a series of personal sketches of various Icarians of the past and present, many of whom have been remarkable characters and have had curious and noteworthy careers. Among those described are: A. A. Marchand, J. B. Gérard, A. Picquenard, P. J. Favard, M. Mercadier, Eugene Mourot, Émile Fugier, E. F. Bettanier, Antoine von Gauvain, A. Souva, Émile Peron, J. Laforgue, A. Tanguy, S. Dereure, Charles Levy, Jules Leroux (pére), Pierre Leroux (fils) and Jules Leroux (fils), Adam Dehay, and Émile Bée.

The Beginnings of Connecticut. By Charles H. Levermore.

[Abstract of a paper presented to the Historical and Political Science Association, March 28, 1884].

I.—*The Dutch and the Pilgrims.* In the valley of the Connecticut river Dutchmen and Englishmen first wrestled earnestly together for the possession of the New World. The colony of Plymouth became, in the main, a trading corporation, reaching out one hand to the Kennebec and the other to the Connecticut. Still more exclusively upon an economic basis was the settlement at Manhattan. Dutch traders blazed the way where Englishmen afterwards followed. After Adrian Block's interesting voyage of exploration in his American-built yacht, "The Unrest," there are accumulating evidences of the presence of Dutch traders and settlers upon the "Versch," or Connecticut river. Of these evidences New England historians have either been ignorant or contemptuous. Out of the invaluable treasures of the Holland Documents proofs are drawn of a Dutch settlement upon the river so early as 1623. The deposition of the Walloon, Catelina Trico, in 1688 concerning the fort at "Harford river" is especially important. When Isaac De Rasier headed an embassy from Fort Amsterdam to Plymouth in 1627, and smote upon the ears of the quiet villagers with "a great noyse of trumpeters," the English obtained their first knowledge of the Connecticut valley, and were invited to share it with the Dutch. The English were also urged to visit the river by Indians, one of whom "had lived in England with Sir Walter Raleigh." In the correspondence between the two English colonies, and with the agents of the Lords States-General upon the question of jurisdiction, the Massachusetts Bay Colony played the part of the dog in the manger. In 1633 Plymouth was at Windsor, side by side with New Amsterdam in the race for pelf and peltry. The influx of Massachusetts emigrants soon after crowded both the rivals to the wall. The correspondence between Governor Bradford and the Massachusetts authorities shows too much ill-temper for the successful preservation even of the usual devout forms of expression. Plymouth colony had planned to remove bodily to the lands thus wrested from her. But of contention she had already had enough at Kennebec. It was feared, as Hubbard says, that "they all and the Gospel might be brought under the reproach of cutting one another's throats for beaver." David Peterson DeVries' account of his visit in 1639 to the Dutch fort, "The Hope," at Hartford, affords a lively picture of the numerous undignified squabbles between the Dutchmen and their English neighbors. There is an amusing story of the international fraternizing over a feast of cherries at the Dutch fort, and of the escape of a drunken Englishman from the whipping-post on account of that temporary era of good feeling. The Dutch cherry trees unfortunately could not bear fruit all the year round. Ill-feeling increased in intensity until the seizure of the fort in 1653, and its sequestration two years later.

II.—*The Massachusetts Bay Colony at Connecticut.* Out of a political and religious fermentation which pervaded every portion of the Massachusetts Bay Colony, there arose a social element, demanding democratic reform in the State, and Separatist reform in the Church. The political defeat of Winthrop and the colonization of Connecticut were two prominent results of the new movement. The central figure in the popular party during the conflict was the Rev. Thos. Hooker, the father of Connecticut. He was self-centered, magnetic, and a firm republican. In mildness he was surpassed by the even-tempered Winthrop, but his warm sympathies inspired him with a belief in the People that seemed foolish to the sagacious Governor. In public spirit and tolerant disposition he shows to advantage by the side of his rival, "the flexible Cotton." Against the conception of Roger Ludlow's character embodied in the new edition of Bancroft's "History," a protest must be filed. The testimony of his own life proves him to have been a selfish, ambitious, vindictive man, doomed to be rejected in the end by both Massachusetts and Connecticut. The democratic tendencies which are traced throughout Connecticut's constitutional development provoked much dolorous moralizing from Winthrop, who mourned that Mr. Hooker's work must "lack the blessing." Connecticut's treatment of Indians deserves a special word of commendation. Such has been the magic force of legend and of poetically inspired school-histories, that, for a century, the youth of America have heard, with awe and shame, the voices of the Delaware redskins, chanting "We will live in love with William Penn and his children, so long as the sun and moon shall shine." More than one colony surpassed Pennsylvania in a policy of kindness to the savages. Connecticut Indians live to-day upon lands that belonged to Sachem Uncas. During the contentions with Massachusetts that ensued upon the quarrel with Magistrate Pyncheon of Springfield, Connecticut appeared as the first American champion of the doctrine of "Home-instructions to representatives." A view of the economic life of the colony down to the time of the Revolution justifies that impression of slow and sure growth which is suggested in Connecticut's sobriquet "The land of steady habits."

III.—*The Colonies of New Haven and Saybrook.* A survey of the early fortunes of New Haven and Connecticut reveals the former declining from affluence to comparative poverty, while Connecticut rises from distress to comfort and power. The causes of these phenomena are to be found, not in New Haven's peculiar polity of the Church and State, but in economic conditions, in the fruitless endeavors to build a commercial metropolis on the edge of a wilderness. The complete history of the Saybrook Colony has never been written. The story is one of attempts, not of realizations. It was the only endeavor to colonize Connecticut under English chartered rights. The prospects of the colony and the purposes of its owners, Say and Sele, Pym, Hampden, Saltonstall, and the rest, varied with the fluctuating fortunes of the Puritan party in England. The first settlement was made, not at Saybrook, but at Windsor, in 1635, by Sir Richard Saltonstall's company. The letters of the knight bear abundant witness to the utter overthrow of the new foundation by the in-rushing tide of Massachusetts immigration. His just claims were finally satisfied in 1642. Massachusetts tried to use the Saybrook colony as a lever for weakening the independent position of Connecticut. The younger Winthrop's authority as Governor of Saybrook facilitated this purpose—until the time of the arrival of Col. Fenwick. Fenwick's expectations became disappointments, and, in 1644, after a separate existence of nine years, Saybrook was absorbed by the colony of Connecticut farmers.

BIOLOGY.

List of Coleoptera found in the vicinity of Baltimore. By O. Lugger.

[Abstract of a paper read before the Baltimore Naturalists' Field Club, January 16, 1884].

Although lacking a large river, the banks of which have proven everywhere such an excellent field to collect specimens of natural history, and which are always rich in species of beetles, the vicinity of Baltimore is by

no means an unfavorable locality for coleoptera. Nearly every variety of soil and surface can be found within a short distance from this city. High and wooded hills with steep or gently sloping sides; broad valleys and narrow ravines, with many streams and thousands of springs; rocky hill-sides and sandy spots abound everywhere, and produce all the necessary conditions for the existence of animal and vegetable life, thus affording a very rich field for the collector. The districts along our tidewater again are the homes of many species not found elsewhere in this vicinity.

All the usual methods of catching beetles have been resorted to. Sieving, beating, sweeping, and the different traps in vogue among coleopterists, all have produced their share of species in the following list. They have also been bred in cages constructed for this purpose. By collecting very early in spring and late in autumn, and even during sunny days in mid-winter, many species were obtained that belong to the Canadian fauna, and which otherwise could not be found in this vicinity.

The following list is the work of eight years' collecting, and contains 2259 species. It includes by no means all the species that can be found in this region, and judging from those found near Washington, fully 700 more will be found in time.

The arrangement of families followed in this list is that of the late Dr. Leconte and of Dr. Horn, published two years ago by the Smithsonian Institution.

Families.	*Gen.*	*Sp.*
Cicindelidæ	2	25
Carabidæ	64	258
Haliplidæ	2	5
Dytiscidæ	14	46
Gyrinidæ	2	5
Hydrophilidæ	13	37
Silphidæ	11	29
Scydmænidæ	2	11
Pselaphidæ	12	26
Staphylinidæ	65	204
Trichopterygidæ	5	5
Scaphidiidæ	3	6
Phalacridæ	3	6
Corylophidæ	5	6
Coccinellidæ	17	33
Endomychidæ	7	11
Erotylidæ	7	24
Colydiidæ	11	15
Rhyssodidæ	2	2
Cucujidæ	9	22
Cryptophagidæ	7	8
Mycetophagidæ	5	15
Dermestidæ	7	15
Histeridæ	13	45
Nitidulidæ	20	43
Trogositidæ	4	10
Monotomidæ	4	8
Lathridiidæ	3	7
Derodontidæ	1	1
Byrrhidæ	4	5
Georyssidæ	1	1
Parnidæ	5	10
Heteroceridæ	1	3
Dascyllidæ	10	22
Rhipiceridæ	2	3
Elateridæ	35	106
Throscidæ	2	3
Buprestidæ	17	58
Lampyridæ	21	55
Malachiidæ	5	12
Cleridæ	12	29
Ptinidæ	21	31
Cupesidæ	1	2
Cioidæ	4	5
Lucanidæ	5	6
Scarabæidæ	43	143
Spondylidæ	1	1
Cerambycidæ	74	163
Chrysomelidæ	67	190
Bruchidæ	2	15
Tenebrionidæ	35	59
Cistellidæ	7	17
Lagriidæ	2	3
Melandryidæ	17	25
Pythidæ	2	2
Oedemeridæ	4	8
Cephaloidæ	1	1
Mordellidæ	5	40
Anthicidæ	9	28
Pyrochroidæ	2	4
Meloidæ	8	14
Rhipiphoridæ	3	6
Rhinomaceridæ	1	2
Rhynchitidæ	4	9
Attelabidæ	1	3
Otiorhynchidæ	12	12
Curculionidæ	61	165
Brenthidæ	1	1
Calandridæ	10	22
Scolytidæ	19	32
Authribidæ	9	15
71 families, 857 gen., 2259 sp.		

PETROGRAPHY.

Preliminary Notice of the Gabbros and associated Hornblende rocks in the vicinity of Baltimore. By G. H. WILLIAMS.

In view of the limited number of occurrences of typical gabbro which have thus far been described within the United States, it may be interesting to briefly notice two well marked types of this rock that are to be found in the immediate vicinity of Baltimore. Inasmuch as their mode of occurrence promises to throw additional light upon one of the much mooted questions of archaean geology, viz: the origin of lenticular bodies of hornblende rocks, so often interbedded in the old gneisses, the full description of these gabbros, which their geological importance warrants, must be postponed until a more complete study of their field relations is possible.

An irregularly oval area to the west and northwest of the city of Baltimore, whose greatest length, extending from the Patapsco River to Smith's avenue, is about 10 miles and whose greatest width is about 5 miles, is covered with a compact black rock, locally known as "Niggerhead." Although at first sight this all seems to be alike, a more careful examination reveals the fact that there are three altogether distinct kinds of rock within this area. By far the most common of these is a very compact mixture of dark green hornblende and anorthite, which frequently shows unmistakable signs of stratification. Associated with this rock, which we will call an *anorthite amphibolite*, is another of a dark purple color and quite massive in its character. This latter is most frequent toward the centre of the area, its best exposures being along the line of the Western Maryland Rail Road near Mount Hope. It seems to occur in irregular patches of all possible dimensions, always surrounded by the amphibolite, between which and it there is never a sharp line of contact, but everywhere a gradual transition.

A microscopic examination of the purple rock from all the principal points of its occurrence shows that it is an exceedingly fresh, fine grained mixture of triclinic feldspar, diallage and hypersthene, with accessory hornblende, magnetite, apatite, and very rarely olivine. Its structure is altogether granular or granitic, and the rock is therefore to be defined as a *hypersthene gabbro* or *hyperite*. The feldspar was isolated and proved to be from both an optical and chemical examination, bytownite, a member of the triclinic series between labradorite and anorthite. It is not otherwise remarkable, except for the presence of beautiful inclusions, so characteristic of the feldspar of gabbros. The diallage is without crystalline form, of a light green color in the section and devoid of all pleochroism. The hypersthene, whose orthorhombic character is easily proven in cleavage pieces, is strongly pleochroic, the colors being arranged as usual, and contains its characteristic inclusions in great perfection. Aside from these essential constituents there is often present a brownish-yellow hornblende, which is undoubtedly original and not paramorphic in its nature, as is abundantly proved by its occurrence in the freshest and most unaltered specimens, and the fact that it is of a totally different character from the really paramorphic hornblende to be described farther on.

The hornblende rock or anorthite amphibolite retains throughout the entire area a constancy in its petrographical character quite remarkable for a member of the crystalline schists. The only observable differences are slight local variations in the coarseness of grain and distinctness of stratification. It always shows in a hand-specimen a satiny lustre, and is seen under the microscope to be composed of a triclinic feldspar and confused aggregates of amphibole, possessing the green color, strong pleochroism, and all the other properties of common hornblende. The feldspar was isolated and found to be nearly identical with that of the gabbro, although in the special specimen examined, slightly more basic. In its chemical constitution and optical properties it agreed better with anorthite than with bytownite. Epidote was frequently observed in nearly colorless crystals, generally forming a rim around and projecting into the feldspar. Quartz is very rarely present, and never except in minute quantities.

It will be seen at once that the association of these rocks is precisely similar to that at several well-known European localities, where they have of late been the subject of much careful study. Near Rosswein and Penig in Saxony lenticular masses of hypersthene gabbro occur imbedded in hornblende schists, and from their peculiar structure are called "Flasergabbros." Naumann regarded them as eruptive, but Stelzner, Credner, and Dathe consider them as metamorphosed sediments. Reusch has lately described the same association and structure at Bergen in Norway, where he considers the rocks to be metamorphosed lava streams and tuffa beds. Becke has also described the same formation in Austria. The Baltimore gabbro area gains therefore much in interest by its close similiarity to these classic European localities.

Whether the shape of the masses of fresh hypersthene gabbro in the Baltimore region is as a rule lenticular or not, it is difficult to say. If they are, the great size of the larger ones and the steeply tilted position of the hornblende beds would cause them to appear rather as alternating bands, and in the case of the smaller masses the close similarity in the general appearance of the two rocks and the absence of any sharp line of contact between them renders the assigning of any definite limits to such masses nearly impossible. The general impression conveyed is that of quite irregular patches of gabbro occurring in the compact amphibolite and everywhere passing by imperceptible gradations into it.

The association of these two rocks is so intimate and the transition of one into the other so gradual, that the idea of the subsequent origin of the gabbro, as a mass intruded into the amphibolite, is out of the question; on the other hand they both retain their essential characteristics throughout the entire area, in spite of their intimate mixture, with far too much constancy to allow of the supposition that they were originally interstratified sedimentary beds whose different constitution furnished, when metamorphosed, these two different products. In fact the separation of these rocks has only a petrographical interest. Geologically they form one body as is shown, aside from their close field relations, by the great similarity of their chemical composition and the fact that the area they occupy is so sharply defined against the gneisses and mica schists which surround it. Whatever

may have been their primary origin, they are essentially the same rock, and the idea naturally suggests itself that one may be an alteration product (not however a decomposition product) of the other. Now the molecular change of hornblende into augite is known to take place only under circumstances of complete fusion, whereas no phenomenon is better known in petrography than the corresponding change under ordinary conditions of augite to hornblende. The identity of the feldspar in both rocks makes the only real difference between them, the replacement of the pyroxene constituents, diallage and hypersthene, in one by aggregates of green hornblende needles in the other. The idea then that the hornblende was the paramorphic product of the pyroxene lay close at hand, and the study of several series of thin sections made from chips taken at very close intervals along lines where the gradual transition of one rock into the other was especially manifest, have disclosed every step in this process of paramorphosis with great clearness. The pyroxene at first becomes fringed with a zone of fibrous hornblende which is colorless inside like tremolite, but on its exterior edge is somewhat more compact and possesses the usual green color and pleochroic properties of ordinary hornblende. This process of alteration goes on until the pyroxene is altogether replaced by irregular aggregates of hornblende needles, those in the centre being colorless and those on the edge green. The inclusions of the pyroxene have now mostly disappeared but those of the feldspar remain intact. A short distance farther away from the gabbro the hornblende aggregates have become altogether green and the feldspar no longer presents its peculiarly fresh appearance, the characteristic inclusions have disappeared, and it is filled with actinolite needles or fringed with epidote. This process, though the usual one, was by no means the only one observed. Sometimes the hornblende, instead of being aggregates of compact green needles, retains that very fine parallel fibrous appearance characteristic of uralite. The process is also somewhat different if the gabbro contained original brown hornblende, which resists the alteration longer than the pyroxene, although it also appears finally to go over into the green variety.

The microscopical study of these two rocks, then, as well as their field relations, as far as these have yet been deciphered, seems to indicate that they are essentially the same and that the gabbro was the original type. What their primary origin was it is difficult to say, but the sharp line of demarkation by which this area is separated from the light-colored gneisses and mica schists which surround it render it at least very possible that the whole was an eruptive mass, intruded as gabbro, and subsequently partially altered by paramorphism to anorthite-amphibolite. To this theory the more or less perfect schistose structure of the latter rock presents no serious objection. The great lateral pressure to which, as the microscope plainly shows, these rocks have been subjected would naturally have tended to produce a schistose structure resembling slaty cleavage. In fact this pressure may have been the very cause of the alteration of pyroxene to amphibole, which would account for the schistose structure being most manifest where this alteration is most complete.

The third of the rocks mentioned as occurring in the particular area under discussion is altogether different in character from the two already described. In its freshest state it is composed largely of olivine together with considerable diallage and bronzite and very little feldspar. It may perhaps best be classed as an *olivine bronzite gabbro*, although the almost total absence of feldspar in some varieties would throw it into the family of the *peridotites*. Macroscopically this rock appears as a dark brown base in which large plates of yellowish bronzite and smaller glistening crystals of black diallage together with a few scattered specks of white feldspar are readily detected with the unaided eye. Under the microscope the base is seen to be composed altogether of olivine and smaller grains or shreds of magnetite separated out in the process of serpentinization, which has always commenced and some cases progressed very far. Neither the bronzite nor diallage present any marked peculiarities. Both are nearly destitute of pleochroism in a thin section, but are readily distinguished by their difference of size, color, and optical orientation. The feldspar is anorthite and is interesting as showing a rare form of alteration into some zeolite mineral instead of into calcite or kaolin as usual. This zeolite, whose exact nature has not yet been determined, forms aggregates of fibrous crystals resembling natrolite and is perhaps scolecite. This feldspar also exhibits in great perfection the border of actinolite (?) fibers, described by Törnebohm, produced by the mutual reaction between the olivine and feldspar substance wherever these come in contact.

This rock occurs at several localities within the gabbro area, generally in the form of narrow bands resembling dykes, though sometimes in masses of considerable size. It is often associated with serpentine which has plainly originated from its alteration, and suggests the idea that the large mass of serpentine forming the Bare Hills, about 7 miles north of Baltimore, may have also originated in the same way. At all localities where it is at all fresh the olivine gabbro retains its main character with great constancy. From the following chemical analysis of this rock by Dr. Leroy McCay of the Green School of Science, Princeton College, it will be seen that it must be peculiarly subject to alteration. Besides its change to serpentine, it is seen sometimes to pass over into a light green talcose rock, which also occurs alone in bands cutting the hypersthene gabbro, and whose presence in this form is thus explained:

SiO_2	41.00
Al_2O_3	7.58
Fe_2O_3	5.99
FeO	4.63
CaO	10.08
MgO	23.59
Na_2O	.52
CO_2	3.62
H_2O	4.73
	101.74

This is to be regarded as only a preliminary notice of the gabbros about Baltimore. The writer hopes before long to publish a more detailed account of them with illustrations and a number of chemical analyses.

On an excursion Map of Baltimore and its neighborhood.

By A. L. Webster.

At a meeting of the Baltimore Naturalists' Field Club, March 19, 1884, Mr. Webster made a report upon a map of Baltimore and its neighborhood soon to be published for the use of the students of the Johns Hopkins University, of which the following abstract has been prepared.

From the first organization of this Club the want of an accurate and reliable map of Baltimore and its neighborhood has been felt by its members.

The results of their excursions and studies have rolled up a large collection of facts of importance, relating to the distribution of plant and animal life, of physical and topographic peculiarities, and of geological structure.

As notes on these items of interest have accumulated, the need of a comprehensive chart of the area under study has increased proportionately, but something more than a mere excursionists' guide is required, though this is a great desideratum at present.

The classification and systematizing of material must be preceded by the accumulation of a vast number of facts the significance of which, when first presented, is frequently hidden or but hinted at, and only brought into relief by association with others subsequently developed. To prevent the loss of such facts, relating to the physical geography and natural history of the district, through misconception of their importance, a large central chart accessible to all on which to record by a system of cartographic devices each item as noted, is urgently required.

As the delineation becomes more complex it will be beyond the power of a single map to carry the growing load of information, but by a division of the burden and a grouping of great classes of material on independent but similarly prepared base maps, a clear and comprehensive graphical statement can be preserved and a ready means offered of incorporating the new results of advancing study.

With a view to ultimately obtaining such a store house for the fruits of the Field Club's labors a movement was recently made to search out existing maps of the city and its surroundings, to ascertain to what extent they supplied the deficiency and to determine upon the most feasible course toward the ultimate accomplishment of the perfected plan.

A large number of maps of the city, the neighboring counties, and the state were examined without bringing to light any publication suitable to the ends noted. Sufficient scattered material was found, however, from which a serviceable map could be compiled.

A report to this effect was presented to the Trustees of the University with an urgent request for assistance. This was very kindly received and permission granted to have the work begun.

The area to be mapped lies approximately between latitudes 39°-06′-30″, 39°-23′-30″, and longitudes 76°-21′-30″, 76°-51′-00″, and is bounded by a square of twenty-five miles side, the centre of which is the city hall.

Something more than one-fourth of this area has been covered by the accurate triangulation and plane-table work of the U. S. Coast and Geodetic Survey. The remainder has at various times been surveyed and mapped, with more or less accuracy, by numerous engineers; the results of whose work are to be found in atlases of the city of Baltimore, of many of the counties and of the state; as well as in the form of wall-maps, pocket-maps, guides, etc., etc. With the exception of the work of the Coast Survey however, the measurement of altitudes has generally been overlooked.

It was also found that the U. S. Geological Survey is at present compiling a map of the District of Columbia and adjoining country on a scale of two inches to the mile, with twenty foot contours.

The area covered by this work lies between latitudes 38°-47′, 39°-05′, and longitudes 76°-50′, 77°-18′.

Its contiguity to our own limits and the desirability of mutual harmony in scale and general plan is apparent.

With these facts in mind it was decided to have drawn on a polyconic projection with scale of 1: 31,680., or two inches to the mile, a map taken from material furnished by published and official records of the U. S. Coast and Geodetic Survey. This drawing is to serve as a basis for the entire work, but in itself is to remain untouched until results of work of equal standard accuracy can be obtained to join with it. The computed geographical positions of one hundred and forty-four points lying within the district have been furnished by the courtesy of the Survey. From the drawing a tracing is to be made to which material gathered from the most reliable published maps of the remaining area is to be added. By the kindness of the U. S. Geological Survey the reduction of these various plats to the uniform standard scale is being effected by the process of photography and from the resulting prints features desired are transferred to the tracing.

Photolithographic reproductions of the finished tracing, reduced and properly mounted, will serve as convenient pocket-maps for use in the field.

It is to be borne in mind that they will be merely the results of compilation from a variety of sources, the best however at present existing. Many errors will doubtless be found in them, due to inaccuracies in the originals, but it is for the correction of these errors that they are produced.

The tracing is to be hung in an accessible place and items of interest to the various sections or corrections of detected inaccuracies, are to be made upon it or copies of it, from time to time, in accordance with a prescribed plan and system. It will accordingly represent the sum total of information collected up to date.

As existing hypsometric material is worked over and new records made, contours will be introduced, and it is hoped another edition showing the topography in relief will be produced in the future.

To the kind coöperation of the U. S. Coast and Geodetic Survey, the Corps of Engineers of the Army, the U. S. Geological Survey, and various friends much of the progress of the work is due.

REPORTS OF RECENT LECTURES AND ADDRESSES.

VII. Dr. Billings's Lectures on Municipal Hygiene.

Dr. JOHN S. BILLINGS, Surgeon U. S. A., who has been for several years the medical adviser of the Trustees of the Johns Hopkins Hospital in respect to the construction of their buildings, gave in Hopkins Hall during the first half-year, a course of twelve lectures on Municipal Hygiene. The following abstract has been prepared by Mr. Albert L. Webster, Fellow by Courtesy of this University.

Statistics clearly show a growing tendency on the part of the populace of this country to accumulation in cities; the sanitation of cities, therefore, is the sanitary problem of to-day. Apart from all other considerations, the importance of exertion in behalf of the health of the city as a whole, commends itself to our consideration on the ground of individual, self-preservation; on the common business principle that it will pay.

The annual number of deaths in Baltimore is now nearly 9,000, having been for the last two years over 2½ per cent. of the population. If we can prevent only one-tenth of this—that is reduce the rate to 2¼ per cent., or 22.5 per thousand, which certainly can be done, we shall save nine hundred lives, and get rid of one thousand eight hundred sick, who are a constant burden and expense. The money value of this is over a million dollars. The recent experience with small-pox cost the City Treasury over $90,000, to say nothing of the cost of the deaths, and of the sickness to individuals, or the loss to the business of the city, due to the prevalence of the disease. Yet this epidemic might have been prevented at comparatively small expense.

The impulse given to the study of municipal hygiene during the last forty years is largely due to the increased consideration of vital statistics. The figures representing the mortality of a place, are not by themselves the best test of its sanitary condition, but they are, upon the whole, a very good test, and often the only available one.

The importance of accurate and complete vital statistics is but slightly recognized in this country, and the dependent mortality rates accordingly open to more or less doubt. The most fruitful cause of error is connected with the mode of estimating the average living population which has furnished the deaths for a particular period.

The case of Baltimore illustrates the diversity of results attainable by different methods. The population of the city according to the United States Census of 1880 was 332,313. By consulting previous records and applying the ordinary method in use by statisticians, of reckoning proportionate increase in corresponding intervals, the population, June 1st, 1883, would have been 354,720.

The City Health authorities believe these figures to be too small and refuse to accept the census of 1880, estimating the population at that time to have been 393,796, or over 61,000 more than the census, a deficiency in the latter, according to them, of over 15 per cent. Their estimate is based upon the following considerations:

"There are 80,000 registered legal voters in Baltimore; five inhabitants to a legal voter is a fair and reasonable allowance, which would make the population 400,000. The census taken by the police, for our School Board, of children between the ages of six and twenty-one years gave 86,961. This would be a fair estimate of one-fifth of our population, making the same 434,805. . . . Again, there are 90,000 houses in Baltimore. Deduct 10,000 for manufacturing establishments, warehouses, stores, and unoccupied dwellings, estimating five inhabitants to each house (a very low estimate), our population would be 400,000." *

The results of an application of these same methods to the computation of the populations of other cities, and conversely the application of the usual methods of other cities to Baltimore, strongly concur in endorsing the figure obtained by the United States Census.

From the consideration of vital statistics, the following facts are made clear. Large cities have a greater mortality than small ones, and the latter than rural districts. Cities are more dangerous to male than to female lives and especially is this so among children; an excess of female mortality belongs exclusively to rural population. The birth and death-rate is higher among the colored than among the white population.

A large city covers a large area and influences affecting mortality rates vary with different districts lying within this area. Thus, for Baltimore the mean mortality rates for the years 1879–81 inclusive, for the various wards was as follows—

* A. R. Carter, letter in *Sanitary Engineer*, Feb. 15th, 1881, p. 130.

Table Showing the Population and Deaths by Wards of the City of Baltimore for Three Years.

Wards.	Total Population.	Number of Deaths.				Ratio per 1,000.
		1879.	1880.	1881.	Mean.	
1	27,190	578	681	668	609	23.6
2	14,097	294	417	489	400	28.4
3	12,985	313	330	336	326	25.1
4	9,521	202	206	226	211	22.2
5	12,966	307	300	354	320	24.7
6	15,402	433	406	429	423	27.4
7	27,327	619	687	748	685	25.0
8	14,250	306	346	308	320	22.5
9	6,970	232	265	332	276	39.6
10	9,533	230	244	202	225	23.6
11	12,492	182	191	225	199	15.9
12	14,747	270	268	293	277	18.7
13	10,358	220	244	278	246	23.7
14	11,206	258	309	336	301	26.8
15	14,664	408	431	451	430	29.3
16	19,867	445	486	599	510	25.6
17	18,220	476	430	598	501	27.5
18	29,037	653	638	679	657	22.6
19	30,941	656	608	735	666	21.5
20	20,532	536	555	535	542	26.3
Total.	332,305	7,618	8,041	8,816	8,153	25.2

One of the most important factors affecting the health of a city is its water supply. Rain water is not pure water, as it contains impurities washed from the atmosphere, and from the roof which collects it and turns it toward the cistern. Well water in cities is specially objectionable, owing to the practical impossibility of protecting it from contamination. The supposed "sulphur springs" discovered a few years ago in Baltimore and Washington were but wells of dilute sewage.

Natural reservoirs and their outlets, pure running streams, are the best sources from which to draw the water supply of a city and the importance of preserving them in their natural state of freedom from filth is apparent, though not infrequently sadly overlooked.

Water pollution is of less interest to Baltimore than most cities, because the sources of our supply are unusually free from danger of contamination. Yet a small degree of danger exists, and the authorities must see that it does not increase, and that no prescriptive right to discharge refuse into the Gunpowder and its tributaries be established, for no matter how clear the law, there will be difficulties in removing a factory or drain when once established. The trouble is that the city has no jurisdiction over the greater part of the territory from which its supply is obtained. An appeal for protection to the last Legislature failed, the interests of about forty persons outweighing those of 400,000.

Next in importance to the purity of water supply stands the removal and disposal of refuse, ashes, garbage, street sweepings, excreta, foul water, etc.

There are two ways of dealing with it: the ancient, uncivilized way, leaving to the individual householder to get rid of this refuse as best he can; and the co-operative plan where the city undertakes the business. By the first, the greater part of the refuse is kept within the town, in cesspools, yards, or streets, to be disposed of by nature's scavengers.

A very large amount of evidence has been collected, proving that no population living among cesspool emanations can continue to be healthy.

Attempts to prevent soil-pollution by making the cesspools water-tight have proven failures, and involve expensive methods of removal. Such has been the experience of Paris. The annual cost of emptying the 60,000 cesspools of Baltimore—those, that is, that fill up—is about $100,000. The odorless excavating company's vacuum apparatus is employed in the removal of about one-third, the other two-thirds or more sink into the soil. The best water-closet will not be used in a cesspool city, because using much water they fill the vaults too quickly.

The abundance of water in American cities, and the necessity of disposing of the water fouled by domestic use places the water carriage system of sewerage far in advance of other methods for use in this country. The system involves three things: 1, the conveying away of polluted water; 2, drainage of subsoil; 3, removal of surface drainage, and most of the disputes upon this subject turn upon the question of how far these three objects are to be combined in one system.

Small natural water-courses have often been utilized for drainage. These gradually become polluted and offensive by refuse and filth, as in the famous Bayou Gayoso, of Memphis, and when this has progressed so as to constitute a nuisance, the stream is often arched over and called a sewer. But the functions of the two are incompatible.

The proper connection of house fixtures with the sewers is vital to the complete efficiency of the latter.

The refuse and excreta discharged into house drains are not necessarily dangerous to health if they be removed before putrefaction begins. But when, on account of defects in the pipes or traps or of that abominable plan, in which a cesspool beneath the house or in the yard is so connected with the sewer that the overflow only passes off, the sewage reaches the sewers in a state of decomposition, then the sewers must become offensive, no matter how perfectly planned or constructed. This arrangement is common in Philadelphia, and is by no means wholly unknown in Baltimore.

In a properly constructed system of sewers there is little danger from sewer gas, and in improperly constructed ones the danger can be prevented as far as house drains are concerned by means of a proper trap between the house and sewer, and by ventilating the sewers. Probably more offensive gases are produced in soil pipes than come from sewers. Pipes connected with house drains should be arranged according to the following principles, which are simple, but which involve sometimes a difficulty in their practical application. Every fixture through which foul water is to pass shall have a trap as near the fixture as possible; all the traps should be ventilated; the soil pipe should pass out through the roof, full size and be freely open at the top; and in most of our cities, as actually built and sewered, the communication of the air in the soil pipe with that in the sewer should be cut off by a trap on the house side of which should be placed a fresh air inlet. The best traps are those known as the S and half S traps, simple bends in the pipe.

The pre-eminent function of the perfect sewer is to remove with all possible speed offensive refuse without in itself becoming contaminated or offensive. Various so-called systems have been devised to effect this end. The combined system provides by a single line of conduits not only for the removal of house refuse and waste water, but also for the street water in times of rain. This, from several considerations, is a matter of doubtful advisability.

The separate or double system provides independent channels for rain and house water. The latter being carried by small pipes can be readily flushed and kept free from deposits of decomposing filth. The Lieurnur system is a small pipe system in which the excreta is forced by pneumatic pressure to a central collecting station and there disposed of. The expense of construction and maintenance of this system argue strongly against it, aside from other considerations.

As to the paving of streets, cities having heavy traffic, generally pave with blocks of trap rock or granite, known as Belgian blocks, laid in juxtaposition on a bed of sand or gravel. The objections to these pavements are that the bed of gravel and subsoil gradually becomes polluted with organic matters derived from the excreta of animals, all of which in hot and dry weather give rise to offensive and dangerous gases. The best foundation is one of cement concrete. It prevents pollution of subsoil, gives elasticity, which is desirable to prevent injury to vehicles and animals, it distributes the weight and shock of traffic evenly over the surface, and it becomes better and stronger as it grows older. Stone, wood, or asphalt may be laid upon this foundation, but wood is objectionable from a sanitary standpoint. The report of the city commissioner of Baltimore for last year contains communications from several civil engineers relative to the policy to be pursued to secure good pavements. They consider the matter from the technical standpoint of their profession without reference to sanitary considerations, and all recommend the granite block. The cobble-stone pavements which cover most of the streets of Baltimore are much commented on by strangers, and two or three hours' experience produces impressions far from agreeable. The best pavement where there is little heavy traffic is one of asphalt laid on concrete.

With special reference to the sanitary requirements of Baltimore, I should recommend to the authorities and people of the city that more elaborate health statistics be collected and compiled; that the water supply be protected by municipal and State co-operation; that connections with sewerage be made under city supervision; that cesspools be filled; that there be an increase in plumbing inspection; that cobblestone pavements be removed; that an abattoir be constructed; that schools be thoroughly inspected and scholars instructed in hygiene; that public baths be opened; that comfortable and clean tenement-houses be built, and that voluntary organizations be formed to see that these things are properly done.

VIII. Mr. Stillman's Address on the Acropolis of Athens.

The following is an abstract of an address by Mr. WILLIAM J. STILLMAN before the University Archæological Society, on March 22, 1884.

The influence which the site of Athens had on Greek civilization was owing to its impregnable Acropolis in the midst of a magnificent plain which must in that time have been of great fertility, watered by two rivers, with access to the sea at no great distance, all conditions combining to increase wealth and give security to its civil liberty and to the results of its material prosperity. The rock of the Acropolis is one of the most singularly difficult of access amongst all the ancient cities, the only open road to it having been that which winds along under the southern precipices where now are the ruins of the Æsculapeion and the theatre of Dionysos. The western slope, by which it is approached by carriages, was probably in early times non-existent, and the valley between the Acropolis and Mars Hill much deeper, so as to make the western approach as steep as the others. And even in the time of Pausanias this is indicated by his itinerary. There were, however, two secret staircases carried through the rock, one coming up at the northern end of the Propylaea, and the other within the hieron of the Erectheum, the latter being that by which the Persians entered. These were probably part of the early works for the defence of the Acropolis, and are generally thought to have been Pelasgic, though the great work of defence of the Pelasgi, known as the Enneapylon, was probably on the south-western angle of the rock, covering the approach from the south. There is now no trace of the Enneapylon or of the walls of the Pelasgi, that which is shown opposite the temple of Niké Apteros being a comparatively modern wall supporting a terrace. The ancient entrance was, in all probability, where the present gate in common use, is, as is shown by the footprints of the beasts which were led up to the sacrifice, and which have worn the solid rock to considerable depth. The entrance was probably changed when the Propylaea was built and the gate on the western side constructed. This was ruined by Sylla and reconstructed in haste by Valerian at the approach of the Goths, and left as we now have it until the Turks converted the ensemble of the construction on this side into a huge bastion on which they planted their batteries. This bastion was removed by Beulé.

The buildings within the enclosure whose entrance was through the Propylaea are now the Parthenon and Erectheum, many smaller temples and shrines having probably been destroyed. The temple of Niké Apteros was without the Propylaea, and was demolished by the Turks and built into the bastion, to be, piece by piece, recovered and reconstructed in our century.

The description of the Parthenon included a demonstration of the well-known system of curvature of the horizontal lines, which, with the diminution in the inter-columniations and the convergence of the columns, the lecturer considered to be an expedient to increase the apparent size of the temple by exaggerating the perspective illusions. This was illustrated by diagrams and the effect of each variation from the regularity of construction was shown to bear directly on the perspective of the building so as to increase its apparent size.

The same points were illustrated by photographs taken by Mr. Stillman, in the foreground of one of which were shown a number of unfinished drums of the Parthenon columns which had been, from defects discovered after they had been brought up, rejected, and which still lie on a bed of fragments of marble covering the débris of the buildings destroyed in the Persian sack of the Acropolis. In this stratum of débris, which varied from two to six feet in thickness, and which has recently been excavated by the Archæological Society of Athens, are found many fragments of bronze and iron with carbonized wood; and, digging into the exposed face of the mass, the lecturer discovered many relics of the conflagration, amongst them a bronze archaic ornament (which he presented to the Society), and a deposit of barley, pease, and beans, which though completely carbonized by time, had not been burned and still retained their shape. An account of the Erectheum with its triple sanctuary, illustrated by photographs showing the various portions in all their views, completed the description.

IX. Mr. Clarke's Address on the Introduction and Fundamental Principle of the Entasis.

The following is an abstract of an address by Mr. JOSEPH THACHER CLARKE before the University Archæological Society, on March 14, 1884.

This paper embodied original researches concerning the nature of the curved outlines of columns of round plan, based upon the suggestion of Thiersch: That the increased diameter of the middle shaft was introduced to overcome an optical deception resulting from the inability of the eye to distinguish a slight convergence in sets of lines apparently parallel. A comparison of those Athenian monuments which have been most accurately measured shows that the principle of this deception was fully understood by the Greek designers of the best period, and was determined by graphical methods. This recognition of the true character of the Entasis was entirely lost before the Renaissance, and replaced by Serlio and Vignola with clumsy and empiric makeshifts.

NOTES ON RECENT PUBLICATIONS.

MARTIN, H. NEWELL and W. A. MOALE. Handbook of Vertebrate Dissection: *Part III.* How to Dissect a Rodent. (*New York: Macmillan & Co., pp. 85, 3 plates*).

"This little book, like its predecessors in the same series (*see notice on page 59 of Circular 21*) is designed for use at the dissecting-table, and not to take the place of attendance on lectures or the study of a text-book of comparative anatomy. We have assumed that the teacher or text-book will supply such references to original sources as it is desirable that students should be acquainted with, and have accordingly entirely omitted all such. As some critics of Parts I and II appear to have thought that such omission made it possible that the discoveries of others should be credited to us, we desire to state that, so far as we know, no new fact in mammalian or rat anatomy is to be found in the following pages, nor any novel method of dissecting. What we have attempted is to make it easy for a student to learn practically what a mammal, regarded from a morphological standpoint, is. In pursuance of this plan, details which are diagnostic or generally characteristic of mammalia have been treated with more fullness than generic or specific peculiarities.

"From a certain point of view the title of the book may seem a little absurd. The methods suitable for the satisfactory dissection of a rat would assuredly be quite inapplicable to the practical study of the anatomy of a whale or an elephant. But to the student who dissects, not to learn the detailed anatomy of any one species, but the common structural character of a class, it matters little which animal is selected if it be readily obtainable and fairly typical. A book giving directions for the dissection of any such mammalian species may be fairly entitled 'How to Dissect a Mammal.'

"Our choice of the rat was largely determined by its abundance and wide distribution, and the fact that no one is likely to object to the killing of as many rats as can be caught. The larger size of dogs and cats would have been to a certain extent an advantage, but domesticated animals are not to be easily obtained in such numbers as to provide a liberal supply of material for students. Further, we feel sure that he who aspires to become a comparative anatomist, and yet finds a rat too small for the observation of all the main facts in its structure, has mistaken his vocation."—*From the Preface.*

HALL, G. STANLEY and HARTWELL, E. M. Bilateral Asymmetry of Function. (*Mind, London, No. 33, pp. 17, 8°*).

This article consists of two parts, and is to be taken merely as a preliminary account of an attempt by the authors to study comprehensively and in accordance with modern scientific methods, the problem of the relation of right- and left-sidedness to the more general law of bilateral symmetry as regards form and function in animals, especially man.

Part I contains a summary statement concerning the facts observed in the fields of anatomy, physiology, pathology, clinical medicine, and zoölogy, regarding asymmetrical structure and unbalanced functions in paired viscera, limbs and sense organs, together with a brief review of the hypotheses offered in explanation of the facts.

A bibliography of the more important literature of the subject is promised by the authors.

In Part II it is stated that a consideration of the facts and opinions brought together in Part I has led the authors "to think that other methods than those hitherto applied might bring us into closer quarters with the comprehensive bilateral problem. Of these methods two were considered: 1. Operations on the corpus callosum and cerebellum of animals, and perhaps the pyramids, to partially isolate the action of the hemispheres, and also to reduce the action of one of them. 2. More accurate measurements of the bilateral asymmetry of function; especially as regards (*a*) the upper extremity, (*b*) the lower extremity, (*c*) binocular vision."

This section is devoted to an account of investigations made by the authors, according to the second method, applied to the arms. The description of experiments made and the statement of results which occupy the remainder of the section present no substantial differences from the results of the investigation recounted by E. M. Hartwell before the University Scientific Association, May 2, 1883, in his paper "On the Relation of Bilateral Symmetry to Function." An abstract of the paper referred to may be found in *Circular No.* 25, *p.* 149.

HALL, G. STANLEY. (*Editor*). Pedagogical Library, Vol. I.—Diesterweg's Methods of Teaching History, with papers by Professors Herbert B. Adams, C. K. Adams, John W. Burgess, E. Emerton, W. F. Allen, and Mr. T. W. Higginson. (*Boston: Ginn, Heath & Co. xii, 208 and 92 pp. 12mo.*)

This book is intended to be the first of a series entitled a "Pedagogical Library," devoted to methods of teaching, one volume of which is to be occupied with each of the more important branches of study in grammar and high schools. History was chosen as the subject of the first volume from a conviction that no subject so widely taught in schools is, on the whole, taught so poorly. The editor in his preface urges the need of securing better instruction, first, by improving the special training of teachers of history, and second, by increasing the time devoted to instruction.

The book consists of three parts. The first half of it is occupied by a monograph on instruction in history, translated from Diesterweg's *Wegweiser zur Bildung für deutsche Lehrer*, in which the meaning and use of history, and various questions in regard to the method of teaching it, are treated with fullness. Part II consists of brief contributions by prominent American historical teachers. Dr. H. B. Adams describes the methods and results of topical study of history in his classes at the Johns Hopkins University and at Smith College, and calls attention to the utility of beginning historical work with the investigation of local life. Prof. C. K. Adams suggests some improvements in American historical teaching to be derived from the study of German methods, and explains the plans pursued in the School of Political Science of Michigan University. Prof. J. W. Burgess describes the system followed in the School of Political Science connected with Columbia College. Dr. E. Emerton, of Harvard, shows the advantages of an application of the seminary method to historical teaching in American colleges. An important page or two on the use which may be made of physical geography, and a few words by Col. Higginson on the reasons why children dislike history, conclude this portion of the book. Part III, by Prof. W. F. Allen, consists of classified lists of the most useful historical works in English and of selected topics for class use, with some suggestions as to the use of the latter.

J. F. J.

DIPPOLD, G. THEODORE. The Great Epics of Mediæval Germany. An Outline of their Contents and History. (*Boston: Roberts Brothers. 1884. 223 pp., 12mo.*)

This is a reprint of the first issue of the book of September, 1882. "Although no claim is made to present here anything like a history of Mediæval German poetry, it will be found that the subject, as it comes within the scope of the plan announced, has been more fully treated on the following pages than in any work hitherto published in this country or in England."—(*Extract from Preface.*)

AMERICAN JOURNAL OF PHILOLOGY. Edited by Professor Gildersleeve. Vol. IV. Whole No. 16.

Article I.—The Noctes Atticae *of Aulus Gellius.* By HENRY NETTLESHIP.

A large proportion of the surviving Greek and Latin literature consists of extracts and epitomes. The passion for making *florilegia* and miscellanies of all kinds began among the Romans in the first century after Christ and continued in activity for a long subsequent period. The *Noctes Atticae* of Gellius is only one specimen of the results which this passion produced. Prof. Nettleship gives a sketch of the life and career of Aulus Gellius, who belonged to a very old Italian family, was born about 123 A. D., was educated at Rome and studied at Athens in the time of Herodes Atticus. After his return from Athens to Rome he fell under the influence of Favorinus, an influence which extended at least beyond the time at which he entered upon professional life. What that professional life was Gellius does not tell us explicitly, but references are made to judicial functions. The title *Noctes Atticae* was given to the book as a record of the fact that Gellius began to make his collections during the long winter evenings of his student years at Rome. It is professedly a handbook of miscellaneous information; he aims at being comparatively popular. The attempts to enliven his lessons are amusing by reason of the uniformity of the devices employed. There are many marks of carelessness in composition, inconsistencies in the dialogue, re-introduction of the same interlocutor, extracts carelessly torn from the context, allusions to things the writer has nowhere mentioned, promises that are nowhere performed.

Prof. Nettleship then analyzes the whole book according to the subjects of which it treats, and discusses the sources from which Gellius derived his knowledge. The element of purely miscellaneous information is comparatively small and does not include much more than an eighth part of the whole work. A large part is given to philosophy, something to literary criticism, a respectable *quota* to history and Roman antiquities, more than a quarter of the whole to lexicography and etymology, and something considerable to grammar and textual criticism. Large as is the amount of discussion and information bearing upon philosophical questions, that devoted to lexicography, grammar, and criticism of text and style, by far outweighs it both in quantity and in value. The phenomenon is typical of the state of Italian taste and feeling. Only the antiquarian impulse retains any life. The age has no vigor of its own but builds the sepulchres of the prophets and waits for inspiration to rise from the past.

Article II.—On the Final Sentence in Greek. By B. L. GILDERSLEEVE.

Read before the Johns Hopkins Philological Association at their February meeting, 1884. (*See p.* 73 *of this Circular*).

Article III.—T. L. Beddoes, A Survival in Style. I. By HENRY WOOD.

Read before the Johns Hopkins Philological Association at their December meeting, 1883. (*See p.* 76 *of this Circular*).

Article IV.—Notes. 1. *John Evelyn's Plan for the Improvement of the English Language.* By H. E. SHEPHERD.

2. *Mercator, v.* 524. By MINTON WARREN. (*See p.* 56 *of Circular* 29).

Article V.—List of Irregular (Strong) Verbs in Béowulf. By JAMES A. HARRISON.

This number contains *Reviews* of *Guest's History of English Rhythms* by J. M. GARNETT, of *Gartner's Raetoromanische Grammatik, Ulrich's Bifrun's Uebersetzung des Neuen Testaments, Förster's Altfranzösische Bibliothek* by A. M. ELLIOTT, of *Mather's Aeschylus' Prometheus Bound* by — Y ——, of *Dunbar's Concordance to Aristophanes* by C. D. MORRIS, of *Engelbrecht's Studia Terentiana, Wölfflin's Archiv für Lateinische Lexicographie u. Grammatik*, and *Ribbeck's Emendationum Mercatoris Plautinae Spicilegium* by MINTON WARREN. Brief mention is also made of *Schuchardt's Kreolische Studien, Internationale Zeitschrift für Allgemeine Sprachwissenschaft, Weil's Harangues de Démosthène, Jebb's Oedipus Tyrannus*, the new edition of *Cauer's Delectus, Gitlbauer's Babrii Fabulae*, and *Fränkel's Quellen der Alexanderhistoriker*. The *Reports* give an account of *Englische Studien, Zeitschrift der deutschen morgenländischen Gesellschaft, Journal Asiatique, Deutsche Litteraturdenkmale.*

This number closes the volume. Vol. V, No. 1 (whole number 17), will contain articles on *Maximianus* by ROBINSON ELLIS, on the Nahuatl-Spanish Dialect by A. M. ELLIOTT, (see *p.* 74 *of this Circular*), Dr. BLOOMFIELD'S essay on *Irregular Vedic Subjunctives* (see *Johns Hopkins Circulars, p.* 6), a paper on *Researches in Cyrene* by F. B. GODDARD, and Professor HAUPT'S paper on the *Woman's Language* (see *Johns Hopkins Circulars, p.* 51).

Subscription price, $3 per annum, payable to the Editor.

THE NEW BIOLOGICAL LABORATORY

OF THE JOHNS HOPKINS UNIVERSITY.

The recently opened biological laboratory of the Johns Hopkins University is eighty-four by fifty-two feet in external measurement, and consists of three stories and a basement. It is built of Baltimore pressed brick; with steps, entry, window-sills, and band-courses of Cheat-river bluestone. A fact that at once attracts attention is the number and large size of the windows; as the laboratory is free on all sides, it is therefore very well lighted.

On ascending the front steps, and passing through the door, the visitor enters the main hall, from which a wide staircase ascends to the third story, and on which most of the rooms of the first floor open. This floor is given up to the regular class-instruction of students not engaged in special work. It has on it (see plan, fig. 1) a lecture-room with seats for sixty; a storeroom connected with this, for the keeping of diagrams and lecture-apparatus; an administration-room, the headquarters of the chief assistant; a preparation-room containining a supply of the reagents, specimens and material required for the daily practical class-work; and the large general laboratory, thirty-two by forty-eight feet.

The latter has windows on three sides. Around these sides runs a work-table, supported, independently of the floor, on brackets attached to the walls, and affording ample space for thirty students. If necessary, a second table can be set inside this, giving places for fifteen or twenty more. The centre of the room is in part occupied by a dissecting and a chemical table. The latter is supplied with the reagents and appliances for practical work in elementary chemical physiology. The dissecting table has a slate top, and is provided with a sink and water-tap between every two students. The inner side of the room has, against the wall, tables for scales and the warm-water oven; a large hood for the performance of chemical operations calculated to give rise to noxious vapors; and a dumb-waiter leading to the basement, on which articles can be sent up from the storerooms there when called for. Near the centre of the room is a chute, lined with plate-glass (so as to be readily kept clean), and passing direct to the furnace-room below. Through this chute all refuse is at once got rid of. The floor of this room, and of several others in the building, is of asphalt, and the walls of hard cement to a height of two and a half feet. Thus the floor can be flooded with water, and thoroughly cleansed whenever desirable.

The work to be done in this room annually is as follows: by the first-year students, a thorough macroscopic and microscopic examination of about twenty-five selected vegetable and animal organisms illustrative of the course of lectures on general biology, and a study of the embryology of the chick; by second-year students, a course in practical animal physiology and histology a little more extended than that given in Foster and Langley's 'Practical Physiology.'

The second floor (see plan, fig. 2) contains the following rooms: a laboratory for research and advanced study in animal morphology, and a corresponding room for botanical work (used at present as the laboratory of psycho-physiology); a photographing-chamber, with heliostat and other appliances for micro-photography; a library of biological text-books, monographs, and journals; a small lecture-room, capable of seating about thirty; an assistant's private room; a museum containing such typical osteological and other specimens as are needed by students pursuing the regular courses of class-instruction, and the beginning of a collection of the local fauna and flora, made by the members of the field-club; and a store and preparation room for the curator of the museum.

The third floor (see plan, fig. 3) is mainly given up to advanced students in physiology and histology. It has three large work-rooms; a dark chamber for spectroscopic work, for experiments in physiological optics, etc.; the director's private room; a room for the myograph; an assistant's private room; the mechanics' shop, for the construction and repair of instruments; and a small balance-room.

The building being heated by steam supplied from a boiler in the neighboring chemical laboratory, the basement (see plan, fig. 4), which is well lighted, is left free for use. The scientific work-rooms in it are a large, well-equipped room for advanced study in chemical physiology, a balance-room, and a room for the study of animal electricity. The basement also contains a suite of three rooms, which form the janitor's headquarters, where he has charge of the necessary stock of chemicals and glassware, and has also a carpenter's bench, at which he does any simple bit of carpentering required. From one of these rooms a shaft two feet square runs to the top of the building, communicating with each floor. Through this shaft it is intended to run wires to various work-rooms, transmitting electical currents for the running of chronographs, and for similar purposes. The shaft was also planned in the hope that ultimately the clock-work of kymographs and such instruments will be replaced by electrical energy generated by an engine and dynamo in the basement, and distributed thence over the building. The remaining rooms in the basement are, the 'animal room,' fitted up with tanks for the keeping of frogs, terrapins, and so forth; and the furnace-room. The latter contains a cremation-furnace, in which all the combustible *débris* of the laboratory is disposed of, and a boiler and condenser for the preparation of distilled water: it has also in it a small steam-engine, designed to be used for running a centrifugal apparatus.

In the general internal fitting up of the laboratory, the trustees of the university have acted upon the belief that it is, in the long-run, more economical to provide students with furniture which is good and attractive, and trust them to take care of it, than to supply cheap tables and cases, which the average undergraduate, at least, is apt to feel no hesitation in mutilating. The halls and lobbies are comfortably covered with cocoa matting; the tables, instrument cupboards, and cases of drawers are of polished cherry. But there has been no attempt at ostentation: the furniture is all simple; though handsome, and finished in every essential in the best manner. Every drawer runs as smoothly as in the best cabinet work; and each has its own lock, to be opened only by its own key, or the master-key for each floor kept in the administration-room.

The library is a little more luxuriously furnished than the other rooms. It is carpeted, and supplied with armchairs. So many students can only afford to hire rather uncomfortable lodgings, that it was believed desirable to provide in the library a really pleasant study, in which they might find at hand, not only the books they wanted, but writing-tables and other conveniences. None of the books are locked up. The student, on entering, finds before him a list of books which are not to be taken from the room, including text-books, monographs on the plants or animals which are used as types in the regular class-instruction, and the last-received numbers of periodicals: all other books may be taken (subject to call for immediate return at any time) on the student writing his name, and the title of the book he desires to take away, on a card provided for that purpose, and then slipping this through a slit in a locked drawer. The fellows and scholars in the biological department act in turn as librarians for the day, and are present at a stated hour to received books returned, and restore the receipts for them: until the card is returned to its signer, he is responsible for the book. This system of almost absolute freedom in taking books from the library is still on its trial: it has now been in practice for four months, and with the best results. Those who desire to take books home appreciate the trust reposed in them, and also the convenience to them of the present plan, and are anxious to secure its continuance.

The principle on which the library is managed, of inviting students to co-operate with the administrative officers in making it possible to allow the freest use of all books in it compatible with their safety, has been extended to the instruments in the various rooms for advanced work. On admission, each man has assigned to him a microscope, microtome, other histological appliances, and such chemical glass-ware as he is pretty certain to need. For these he signs a receipt, undertaking to restore the articles in good order on demand, or pay a specified sum for them. Glass slides and covers are purchased in quantity, and supplied by the janitor at cost. Other glassware, only occasionally needed, is supplied to any member of the laboratory on requisition, the recipient signing an agreement to return or pay for it. With these exceptions, free use of all the instruments required for such work as he has been permitted to undertake is allowed to every student, on condition that upon removing any piece of apparatus from its drawer or cupboard he shall leave in its place a card bearing his name. The only alternative, of course, is to lock every case, and only issue apparatus on formal application to a special officer. The men are on their honor,

and also know, that, if instruments cannot be traced, the present system must cease. Hitherto the endeavor to secure their aid in carrying out this plan of making all the apparatus accessible with the minimum of trouble or delay, has had most satisfactory results; largely, no doubt, owing to the fact that the majority of the students are graduates old enough to have a sense of responsibility and to influence the younger men. Once a month one of the fellows, or graduate scholars, examines the instrument cupboards in each room, compares their contents with the inventory, notes what piece of apparatus has been taken and who has taken it. If any instrument is not accounted for, he posts a notice asking who has it. During the past four months the latter proceeding has been necessary only three or four times, when students had, in the hurry and excitement of an experiment, forgotten to write the required receipt: in every such case the delinquent has at once come to apologize and explain. What may be called the 'permanent' apparatus in the laboratory, as distinguished from glass tubing and other perishable 'current' apparatus renewed yearly, has cost more than ten thousand dollars: about fifteen hundred dollars are annually provided for repairing and adding to it. During the current year another five hundred dollars has been placed at the disposal of Dr. G. Stanley Hall for the purchase or construction of apparatus for psycho-physiological teaching and research. This stock of instruments is so valuable, and in many cases so easily injured, that a longer trial will, of course, be necessary, before it can be decided whether the present system of leaving every thing unlocked and trusting students to leave an acknowledgment for such instruments as they take, can be continued without undue risk of loss, or injury by carelessness for which no one can be found responsible.

The work for which the laboratory has been planned and built is stated in Professor Martin's lecture, (*see p. 87 of this Circular*). Briefly, it is to train beginners in biology in the fundamental properties of living matter, and the structural and physiological characteristics of the chief groups of plants and animals; in co-operation with the seaside laboratory of the university, to afford opportunities for advanced study and research in animal morphology and embryology; and, ultimately, similar opportunities for advanced students of botany. In addition, very special attention has been giving to providing facilities for class-instruction, advanced study and research in animal physiology and histology; and opportunity for such senior students as intend to become physicians to learn the methods of experimental pathological and therapeutical research, so far as they can be carried on in a laboratory. It is hoped that in this way the biological laboratory may prepare annually some students to enter special laboratories of pathological or pharmacological research more immediately connected with a medical school.—(*Reprinted from Science, March* 21, 1884.)

DIAGRAMS SHOWING THE ARRANGEMENT OF ROOMS.

FIRST FLOOR.

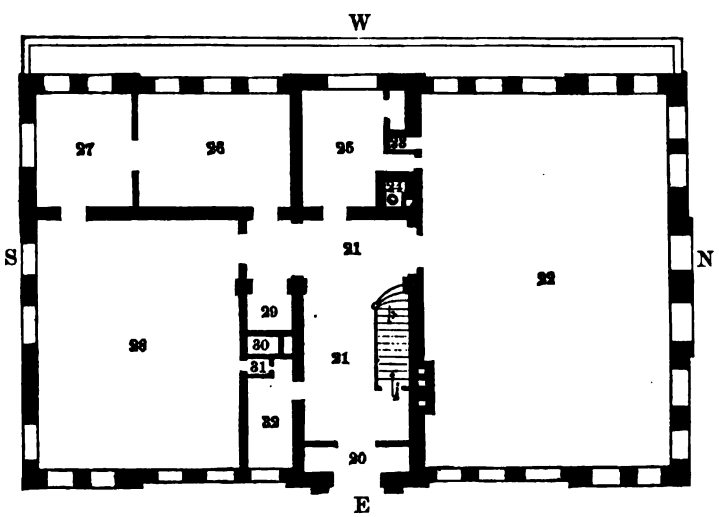

FIGURE 1.—20, vestibule; 21, main hall; 22, work-room for practical instruction of less advanced students; 24, 30, ventilating shafts; 25, storeroom of materials and reagents for general practical class-work; 26, chief assistant's room; 27, storeroom for diagrams and lecture-apparatus; 28, lecture-room; 29, elevator; 32, cloak-room.

SECOND FLOOR.

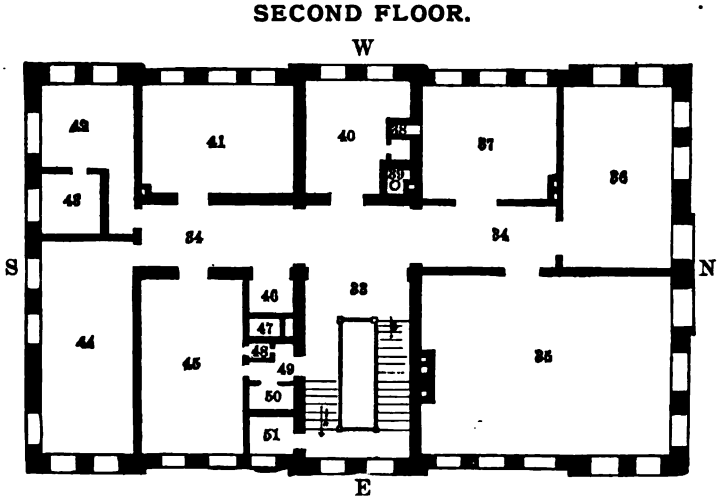

FIGURE 2.—33, 34, hall and corridor; 35, museum; 36, advanced morphology; 37, preparation-room for museum; 40, assistant's room; 41, library; 42, 43, photography; 44, advanced botany; 45, lecture-room; 46, elevator; 47, 39, ventilating shafts; 51, lavatory.

THIRD FLOOR.

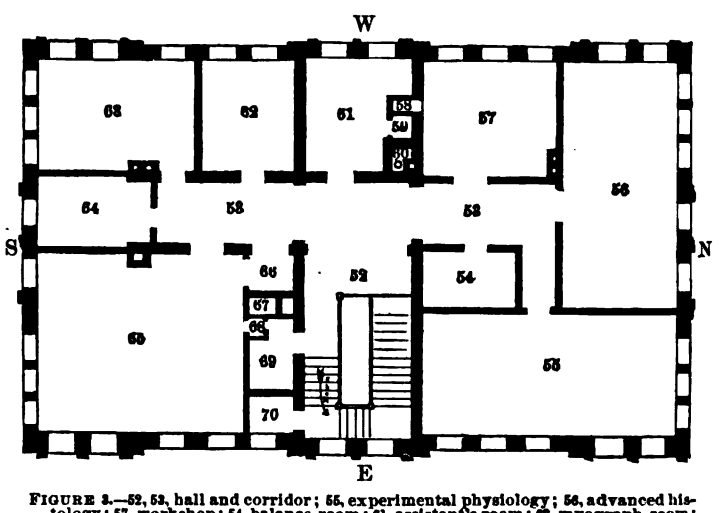

FIGURE 3.—52, 53, hall and corridor; 55, experimental physiology; 56, advanced histology; 57, workshop; 54, balance-room; 61, assistant's room; 62, myograph-room; 63, director's private room; 64, dark chamber; 65, experimental physiology; 66, elevator; 60, 67, ventilating shafts; 69, closet; 70, lavatory.

BASEMENT.

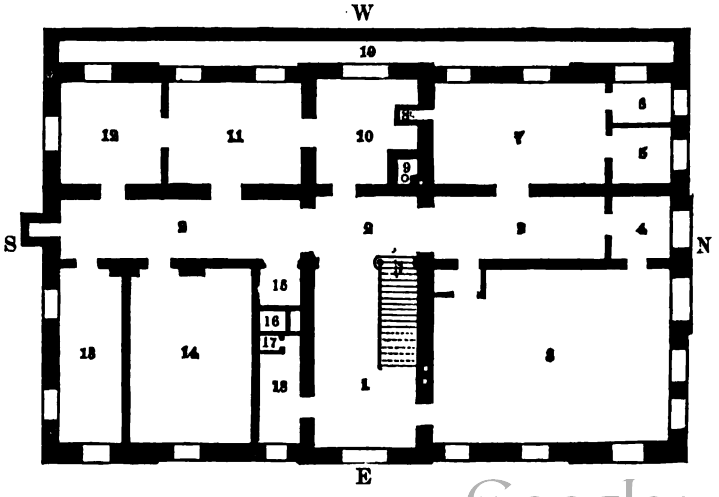

FIGURE 4.—1, 2, entrance and corridor; 3, chemical physiology; 4, balance-room; 7, furnace-room; 10, 11, 12, janitor's store and battery rooms; 13, animal-room; 14, electro-physiology; 15, elevator; 16, 9, ventilating shafts; 18, lavatory.

MODERN PHYSIOLOGICAL LABORATORIES:

WHAT THEY ARE AND WHY THEY ARE.

(An Address delivered on the occasion of the formal Opening of the new Biological Laboratory of the Johns Hopkins University, January 2, 1884).

BY

Professor H. NEWELL MARTIN.

A little more than seven years ago I announced from this platform that the old biological laboratory was ready for use,—that set of rooms in the third story of this building, which, inconvenient in many respects as it was, will, I trust, always be remembered by some of us with affection, and mayhap with a little pride.

This night on which we have met to celebrate the completion of the new laboratory is an occasion for looking forward rather than back. But before proceeding to speak in detail of the new building, I feel sure I do what every one of the members of the biological department present would think me remiss to omit, in pausing a moment to express our gratitude to those to whom we owe it,—first to our founder, Johns Hopkins, for his munificence; and next to his trustees. Probably very few present realize how much time and thought the trustees spent on the building before a stone of the foundation was laid, and during its erection. No one but myself knows how often I have been put in good heart by the cheering words, "Well, Dr. Martin, let us get it right when we are about it." In this connection I cannot refrain from saying, that, while we owe all so much, we owe a special debt of gratitude to Mr. J. Hall Pleasants, the chairman of the building committee. Throughout the summer there was hardly a morning on which he did not visit the building; and that not merely for a glance, but far more often to spend an hour or two hours in or about it, and make sure that all was going right.

The material result of this liberality, forethought, and supervision is that stately building on the top of the hill. Handsome though not ostentatious, comfortable but not luxurious, pleasant to work in without unnecessary finery, it stands there, for its purpose unrivalled in the United States, and not surpassed in the world.

Substantial, solid, well thought out, suited to its ends, and with no frippery about it, it is now for the biologists to see that their work agrees in character with the building.

There are many here to-night, who, not being biologists, may desire to know what such laboratories are for, and why there is any need of them. I shall perhaps best begin my attempt to answer these questions by stating briefly what our own laboratory is.

It is a building constructed primarily to afford facilities for instruction and research in physiology; and secondarily, similar opportunities in allied sciences, as comparative anatomy and botany, some training in which is essential (and the more the better) to everyone who would attain any real knowledge of physiology. As so many distinct branches of biological science are pursued in it, we call it in general the biological laboratory; but it is a biological laboratory deliberately planned that physiology in it shall be queen, and the rest her handmaids. If, therefore, you visit the building prepared to see a great zoölogical museum or an extensive herbarium, you will be disappointed. I do not underrate, and no one connected with this university can,—having in mind the brilliant anatomical researches of Dr. Brooks and others, made among us,—the claims of morphology; and in time I trust we may see a sister building specially designed for study of the structure, forms, and development of plants and animals. But one or the other had to be first chosen unless we were to do two things imperfectly instead of one well, and there were strong reasons for selecting physiology. In the first place, I think even the morphologists will admit that hitherto, and especially in the United States, they have had rather more than their fair share; numerous museums and laboratories have been built for their use; while physiology, if she got anything, has been usually allotted some out-of-the-way room in an entirely unsuitable building, if no one else wanted it; and been very glad to get even that. A second and still stronger reason is, that as medicine is slowly passing out of the regions of empiricism and rule-of-thumb treatment, or mal-treatment, it has become evident that sound physiology is its foundation; and this university will at no distant day have a medical school connected with it.

As you walk presently through the rooms of the new building, and see the many instruments of precision for teaching and research — the batteries, galvanometers, induction-coils, and spectroscopes; the balances, reagents, and other appliances of a chemical laboratory; the microscope for every student; the library of biological books and journals; the photographic appliances; the workshop for the construction and repair of instruments—when you see these things, it may interest you to recall that sixty years ago there was not a single public physiological laboratory in the world; nor was there then, even in any medical school, a special professor of physiology. So late as 1856 Johannes Müller taught in Berlin human anatomy, comparative anatomy, pathological anatomy, physiology, and embryology.

DuBois-Reymond, now himself professor in Berlin, has graphically described the difficulties of the earnest student of physiology, when he attended Müller's lectures in 1840.*

"We were shown a few freshly prepared microscopic specimens (the art of putting up permanent preparations being still unknown), and the circulation of the blood in the frog's web." So much for the histological side.

"We were also shown the experiment of filtering frog's blood to get a colorless clot, an experiment on the roots of the spinal nerves, some reflex movements in a frog, and that opium-poisoning was not conducted along the nerves. There were some better experiments on the physiology of voice,—a subject on which Müller had recently been working; and there was finally a demonstration of the effect upon respiration of dividing the pneumogastric nerves."

In all, you see six experiments or sets of experiments, in the whole course, in addition to the exhibition of some microscope slides; and all these mere demonstrations. It was hardly thought of that a student should use a microscope, or make an experiment, himself. If he desired to do so, the difficulties in his way were such as but few overcame.

"He must experiment in his own lodgings, where on account of his frogs he usually got into trouble with the landlady, and where many researches were impossible—there were no trained assistants to guide him—no public physiological library—no collection of apparatus. We had to roll our own coils, solder our own galvanic elements, make even our own rubber tubing, for at that time it was not an article of commerce. We sawed, planed, and drilled—we filed, turned, and polished. If through the kindness of a teacher a piece of apparatus was lent to us, how we made the most of it—how we studied its idiosyncrasies—above all, how we kept it clean."

Of course certain men, the men who were born to become physiologists, and not mere students of physiology, surmounted these difficulties. One has only to recall the names of DuBois-Reymond himself, and of his contemporaries, Brücke, Helmholtz, Ludwig, Vierordt, Donders, and Claude Bernard, to realize that fact: and undoubtedly there was a good side to it all. Triflers were eliminated; and the class of individuals was unknown who sometimes turn up at modern laboratories (and judging from a good deal of current physiological literature, sometimes get admitted to them) with a burning desire to undertake forthwith a complicated research, though they hardly know an ordinary physiological instrument when they see it; much less know how to handle it. But they cannot wait; they must begin the next morning, believing, I presume, that laboratories are stocked with automatic apparatus,—some sort of physiological sausage-machines, in which you put an animal at one end, turn the handle, and get out a valuable discovery at the other.

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*Emil DuBois-Reymond. *Der physiologische Unterricht, sonst und jetzt.* Berlin, 1878. The quotations from this pamphlet, while giving, I trust, a true idea of the substance of DuBois-Reymond's statements, have been curtailed, and are not to be regarded as literal full translations of the original.—H. N. M.

With one exception, Berlin was not in 1840 worse off than other German universities so far as facilities for physiological study were concerned, and certainly better off than any university in England or the United States. The exception was in Breslau, where the celebrated Purkinje, single-handed, had founded a physiological institute. It has usually been supposed that in this he followed the example of Liebig, who founded at Giessen the first public chemical laboratory; but this, *pace* the chemists, can hardly have been the case. It is to Purkinje that the honor belongs of founding the first public laboratory. Liebig undoubtedly conceived the plan when working in Paris in Gay Lussac's private laboratory, but it was not until 1826 that he began to put it into execution; and at that date Purkinje had already, largely at his own cost, started a physiological laboratory at Breslau, open to students,—on a small scale, it is true, but still the germ of all those great laboratories of physics, chemistry, and biology, which are now found in every civilized country, and to which, more than to anything else, modern science owes its rapid progress. Of these there must be at least forty now organized for physiological work; and almost every year sees an increase in their number. How has this come about in the fifty odd years which have passed since the opening of Purkinje's poorly-equipped and little known workrooms?

First, because of the improvement in philosophy which took place when men began to break loose from the trammels of mediaeval metaphysics, and to realize that a process is not explained by the arbitrary assumption of some hypothetical cause invented to account for it. So long as the phenomena exhibited by living things were regarded, not as manifestations of the properties of the kind of matter of which they were composed, but as exhibitions of the activity of an extrinsic independent entity,—a *pneuma, anima, vital spirit*, or *vital principle* which had temporarily taken up its residence in the body of an animal, but had no more essential connection with that body than a tenant with the house in which he lives,—there was no need for physiological laboratories. Dissection of the dead body might, indeed, be interesting as making known the sort of machine through which the vital force worked,—just as some people find it amusing to visit the former abode of a great author, and see his library and writing-table and inkstand; and there might be discussions as to the locality of the body in which this vital force resided; to carry out our simile, as to what was its favorite armchair. Various guessers placed it in the heart, the lungs, the blood, the brain, and so forth. Paracelsus, with more show of reason, located it in close connection with the stomach, on the top of which he supposed there was seated a chief vital spirit, Archaeus, who superintended digestion. It is mainly to Descartes,* who lived in the earlier half of the seventeenth century, that physiology owes the impulse which set it free from such will-o'-the-wisps. Putting aside all consciousness as the function of the soul, he maintained that all other vital phenomena were due to properties of the material of which the body is composed; and that death was not due to any defect of the soul, but to some alteration or degeneration in some part or parts of the body.

The influence of Descartes, and, in the same half-century, the demonstration of the circulation of the blood by Harvey, gave a great impulse to experimental physiology. Both Harvey and Descartes, however, still believed in a special locally placed vital spirit or *force* which animated the whole bodily frame; as the engine in a great factory moves all the machinery in it. What a muscle did, or a gland did, depended on the structure and properties of the muscle or gland; but the work-power was derived from a force outside those organs,—on vital spirits supplied from the brain along the nerves, or carried to every part in the blood. As the pattern of a carpet depends on the structure and arrangement of the loom,—which loom, however, is worked by a distant steam-engine,—so the results of muscular or glandular activity were believed to be determined by the structure of muscle and gland; but the moving-force to come from some other part of the body.

The next important advance was made by Haller, about the middle of the eighteenth century. He demonstrated that the contracting-power of a muscle did not depend on vital spirits carried to it by nerve or blood, but on properties of the muscle itself. Others had guessed, Haller proved, that the body of one of the higher animals is not a collection of machines worked by a central motor, but a collection of machines each of which is in itself both steam-engine and loom; leaving aside, of course, certain of the purely mechanical supporting and protecting apparatuses of the skeleton. This was the death-blow of the 'vital force' doctrine. Extensions of Haller's method showed that it was possible to destroy the brain and spinal cord of an animal, and separate its muscles, its heart, its nerves, its glands, and yet keep all these isolated organs working as in normal life for many hours. Henceforth the *life* of an animal could not be regarded as an entity residing in one region of the body, from which it animated the rest; the word gradually became a mere convenient phrase for expressing the totality or *resultant* of the actions of the individual organs. Physiologists began to see that they had nothing to do with hunting out a vital force, or with essences or absolutes; that their business was to study the phenomena exhibited by living things, and leave the noumena, if there were such, to amuse metaphysicians. Physiology became more and more a study of the mechanics, physics, and chemistry of living organisms and parts of organisms.

Progress at first was necessarily very slow; physics and chemistry, as we now know them, did not exist. Galvanism was not discovered, osmosis was unknown, the conservation of energy was undreamed of; modern chemistry did not take its rise until the discovery of oxygen by Priestley, and the extension and application of that discovery by Lavoisier towards the close of the last century. Physiology had to wait then, as now, for its advance upon the development of the sciences dealing with simpler forms of matter than those found in living things. But little by little, step after step, so many once mysterious vital processes have been explained as but special illustrations of general physical and chemical laws, that now the physiologist scans each advance in chemistry or physics in full confidence that it will enable him to add others to the phenomena of living bodies, which are in ultimate analysis not peculiar or 'vital,' but simply physico-chemical. Apart from the phenomena of mind, whose mysterious connection with forms of matter he can never hope to explain, if a physiologist were to-day asked what is the object of his science, he would answer, "not the discovery or the localization of a vital force, but the study of the quantity of oxidizable food taken into the stomach, and the quantity of oxygen absorbed in the lungs; the calculation of the energy or force liberated by the combination of the food and oxygen; observation of the way in which that force has been expended, the means by which its distribution has been influenced, and the form in which the unused matter, if any, has been stored."

Once it was recognized that the majority of physiological problems were problems admitting of experimental investigation, the necessity for special collections of apparatus suitable for experiment on living plants and animals, and for affording students an opportunity to study the play of forces in living organisms, had not long to wait for recognition. Physiological laboratories were organized: at first in such rooms as could be spared in buildings constructed for other purposes; later, in structures built for this special end. The first laboratory specially erected for physiological work was built for Vierordt, in Tübingen, less than twenty years ago. So far as I know, our own is the first such building in the United States.

There is still another reason which has combined with the recognition of the independence of physiology as a science to make the modern laboratory, open to all properly prepared students, a possibility; and physiology owes it to this country. I do not forget how Brown-Sequard in Philadelphia clinched and completed Bernard's great discovery of the vaso-motor nerves; nor the researches of Weir Mitchell on the functions of nerve-centres, and the action of snake-poisons; nor, in later years, the researches of Wood on the physiology of fever; and, on various subjects, of Bowditch, Arnold, Flint, Minot, Sewall, Ott, Chittenden, Prudden, Keyt, Sedgwick, and others. But speaking with all the diffidence which one, who, at least by birth, is a foreigner, must feel in expressing such an opinion, I say, that considering the accumulated wealth of this country, the energy which throbs throughout it, and the number of its medical schools, it has not done its fair share in advancing physiological knowledge; but for one thing, which makes the world its debtor. I mean the discovery of anaesthetics. When Morton in 1846, demonstrated in the Massachusetts General Hospital that the inhalation of ether could produce complete insensibility to pain, he laid the foundation-stone of our laboratory, and of many others. No doubt the men whose instincts led them to physiological research, and who realized that by the infliction of temporary pain on a few of the lower animals they were discovering truths which would lead to alleviation of suffering and prolongation of life, not only in countless generations of such animals themselves, but in men and women to the end of time, would have tried to do their work in any case. But those who can steel their hearts to inflict present pain for future gain are few in number. The discovery of anaesthetics has

* See Huxley: *The connection of the biological sciences with medicine* (*The Lancet*, Aug. 13, 1881).

not only led to ten physiological experimenters for each one who would have worked without them, but by making it possible to introduce into the regular course of physiological teaching demonstrations and experiments on living animals, without shocking the moral sense of students or of the community at large, has contributed incalculably to the progress of physiology.

On the occasion of the opening of the old laboratory I used these words: * —

"Physiology is concerned with the phenomena going on in living things, and vital phenomena cannot be observed in dead bodies; and from what I have said you will have gathered that I intend to employ vivisections in teaching. I want, however, to say, once for all, that here, for teaching purposes, no painful experiment will be performed. Fortunately the vast majority of physiological experiments can nowadays be performed without the infliction of pain; either by the administration of some of the many anaesthetics known, or by previous removal of parts of the central nervous system; and such experiments only will be used here for teaching. With regard to physiological research, the case is different. Happily here, too, the number of necessarily painful experiments is very small indeed; but in any case where the furtherance of physiological knowledge is at stake—where the progress of that science is concerned, on which all medicine is based, so far as it is not a mere empiricism—I cannot doubt that we have a right to inflict suffering upon the lower animals, always provided that it be reduced to the minimum possible, and that none but competent persons be allowed to undertake such experiments."

Those words were a declaration of principle, and a pledge given to this community, in which I was about to commence my work. That the work has been carried on for seven years among you, without a murmur of objection reaching my ears, is sufficient proof that Baltimore assents to the principle; and, gratifying as the building of our new laboratory is to me from many points of view, there is none so grateful as its witness, that, in the opinion of our trustees and of my fellow-citizens, I have carried out my pledge. There has been no hole-and-corner secrecy about the matter: the students in the laboratory have been no clique living isolated in a college building; but either your own sons, or boarders scattered among dozens of families in this city; and no room in the laboratory has ever been closed to any student: what we have done has been open to all who cared to know. On this occasion, when we make a fresh start, I desire to re-assert the principle, and repeat the pledge.

We have seen that Haller laid the foundation of our knowledge that the body of one of the higher animals is essentially an aggregation of many organs, each having a sort of life of its own, and in health co-operating harmoniously with others for the common good. In the early part of this century, before scientific thought had freed itself from mediaeval guidance, this doctrine sometimes took fantastic forms. For example, a school arose which taught that each organ represented some one of the lower animals. DuBois-Reymond relates that in 1838 he took down these notes at the lectures of the professor of anthropology: —

"Each organ of the human body answers to a definite animal, is an animal. For example, the freely movable, moist, and slippery tongue is a cuttlefish. The bone of the tongue is attached to no other bone in the skeleton; the cuttlefish has only one bone, and consequently this bone is attached to no other. It follows that the tongue is a cuttlefish."

However, while Professor Steffens and his fellow transcendentalists were theorizing about organs, others were at work studying their structure; and a great step forward was made in the first year of our century by the publication of Bichât's 'Anatomie générale.' Bichât showed that the organs of the body were not the ultimate living units, but were made up of a number of different interwoven textures, or *tissues*, each having vital properties of its own. This discovery paved the way for Schwann and Schleiden, who laid the foundation of the cell-theory; and showed, that, in fundamental structure, animals and plants are alike, the tissues of each being essentially made up of aggregates of more or less modified microscopic living units called *cells*. Our own generation has seen this doctrine completed by the demonstration that the essential constituent of the cell is a peculiar form of matter named protoplasm, and that all the essential phenomena of life can be manifested by microscopic bits of this material; that they can move, feed, assimilate, grow, and multiply; and still further, that, wherever we find any characteristic vital activity, we find some variety of protoplasm. Physiology thus has become reduced in general terms to a study of the faculties of protoplasm; and morphology to a study of the forms which units or aggregates of units of protoplasm, or their products, may assume. The isolation of botany, zoölogy, and physiology, which was threatened through increased division of labor, due to increase of knowledge necessitating a limitation of special study to some one field of biology, was averted; and the reason was given for that principle which we have always insisted upon here,—that beginners shall be taught the broad general laws of living matter before they are permitted to engage in the special study of one department of biology.

If I be asked, what have biological science in general and physiology in particular done for mankind to justify the time and money spent on them during the past fifty years, I admit it to be a perfectly fair question; fortunately it is one very easy to answer. Leaving aside the fruitful practical applications of biological knowledge to agriculture and sanitation, I will confine myself to immediate applications of the biological sciences to the advance of the theory, and, as a consequence, of the art of medicine.

So long as the life of a man was believed to be an external something distinct from his body, but residing in it for a while, diseases were naturally regarded as similar extrinsic essences or entities, which invaded the body from without, and fought the 'vital force.' The business of the physician was to drive out the invader without expelling the vital spirits along with it,—an unfortunate result, which only too often happened. To the physicians of the sixteenth century a fever was some mysterious extraneous thing, to be bled, or sweated, or starved out of the body, much as the medicine-men of savages try to scare it off by beating tomtoms around the patient. Once life was recognized as the sum total of the properties of the organs composing the body such a theory of disease become untenable, and the basis of modern pathology was laid. Disease was no longer a spiritual indivisible essence, but the result of change in the structure of some one or more of the material constituents of the body, leading to abnormal action. The object of the physician became, not to expel an imaginary immaterial enemy, but to restore the altered constituent to its normal condition.

The next great debt which medicine owes to biology is the establishment of the cell-doctrine,—of the fact that the body of each one of us is made up of millions of little living units, each with its own properties, and each in health doing its own business in a certain way under certain conditions; and no one cell being more the seat of life than any other. The activities of certain cells may, indeed, be more fundamentally important to the maintenance of the general life of the aggregate than that of others; but the cells, which, by position or function, are more essential than the rest, are, in final analysis, no more alive than they. Before the acceptance of the cell-doctrine pathologists were practically divided into two camps,—those who believed that all disease was primarily due to changes in the nervous system, and those who ascribed it to alteration of the blood. With the publication of Virchow's 'Cellular pathology' all this was changed. Physicians recognized that the blood and nerves might at the outset be all right, and yet disease originate from abnormal growth or action of the cells of various organs. This new pathology, like the older, was for a time carried to excess. We now know that there may be general diseases primarily due to changes in the nervous system, which binds into a solidarity the organs of the body; or of the blood, which nourishes all: but we have also gained the knowledge that very many, if not the majority, of diseases have a local origin, due to local causes, which must be discovered if the disease is to be successfully combated. An engineer, if he find his machinery running imperfectly, may endeavor to overcome this by building a bigger fire in his furnace, and loading the safety-valve. In other words, he may attribute the defect to general causes; and in so far he would resemble the old pathologists. But the skilled engineer would do something different. If he found his machinery going badly, he would not jump forthwith to the conclusion that it was the fault of the furnace, but would examine every bearing and pivot in his machinery, and, only when he found these all in good working-order, begin to think the defect lay in the furnace or boiler; and in that he would resemble the modern physician instructed in the cell-doctrine.

A third contribution of biology to medical science is the germ-theory as to the causation of an important group of diseases. To it we owe already antiseptic surgery; and we are all now holding our breath in the fervent expectation that in the near future, by its light, we may be able to fight scarlet-fever, diphtheria, and phthisis, not in the bodies of those we love, but in the breeding-places, in dirt and darkness, of certain microscopic plants.

From one point of view the germ-theory may seem a return to the idea that diseases are external entities which attack the body; but note the difference between this form of the doctrine and the ancient! We are no

* *Pop. sc. monthly*, December, 1876.

longer dealing with immaterial, intangible, hypothetic *somethings*; the modern practitioner says, "Well, show me the bacteria, and then prove that they cause the disease: until you can do that, do not bother me about them."

It is worth while, in passing, to note that these three great advances in medical thought were brought about by researches made without any reference to medicine. Haller's purely physiological research into the properties of muscles laid the foundation of a rational conception of disease. The researches of Schwann on the microscopic structure of plants, and since then researches of others on the structure of the lowest animals, led to the cellular pathology. Antiseptic surgery is based on experiments carried out for the sole purpose of investigating the question as to spontaneous generation. My friend Dr. Billings has described "the languid scientific swell, who thinks it bad style to be practical, and who makes it a point to refrain from any investigations which lead to useful results, lest he might be confounded with mere practical men." Well, I am sorry for the swell! because, for the life of me, I cannot see how he can make any investigations at all. The members of his class must be so few in number that we need not waste much grief on them. I never have met with an investigator who would not be rejoiced to find any truth discovered by him put to practical use; and I feel sure that in this day and generation the chief danger is that disproportionate attention will be devoted to practical applications of discoveries already made, to the exclusion of the search for new truth. So far as physiology is concerned, it has done far more for practical medicine since it began its own independent career, than when it was a mere branch of the medical curriculum. All the history of the physical sciences shows that each of them has contributed to the happiness and welfare of mankind in proportion as it has been pursued by its own methods, for its own ends, by its own disciples. As regards physiology, this is strikingly illustrated by a comparison of the value to medicine of the graduation theses of Parisian and German medical students. A candidate for the doctorate of medicine in France or Germany, as in many schools here, must present a graduation thesis on some subject connected with his studies. Every year a certain number select a physiological topic. The French student usually picks out some problem which appears to have a direct bearing on the diagnosis or treatment of disease, while the German very often takes up some physiological matter which on the surface has nothing to do with medicine. Now, any one who will carefully compare for a series of years the graduation theses in physiology of German and French candidates, will discover that even the special practical art of medicine itself is to-day far more indebted to the purely scientific researches of the German students than to those of the French, undertaken with a specific practical end in view. Situated as we shall be here, in close relation to a medical school, and yet not a part of it, I believe we shall be under the best possible conditions for work. Not under too direct pressure from the professional staff and students on the one hand, on the other we shall be kept informed and on the alert as to problems in medicine capable of solution by physiological methods.

I must find time to say a few words as to the connection of physiology with pathology and therapeutics. The business of the physiologist being to gain a thorough knowledge of the properties and functions of every tissue and organ of the body, he has always had for his own purposes to place these tissues under abnormal conditions. To know what a muscle or a gland is, he has to study it not merely in its normal condition, but when heated or cooled, supplied with oxygen or deprived of it, inflamed, or starved; and see how it behaves under the influence of curari, atropine, and other drugs. From the very start of physiological laboratories a good deal of work done in them has necessarily been experimental pathology and experimental therapeutics. I suppose to-day that at least half of the work published from physiological laboratories might be classed under one or other of these heads. And what has been the fruit? I can here refer only to one or two examples. It it not too much to say, that, though inflammation is the commonest and one of the longest studied pathological states, we really knew nothing about it before the experimental researches of Lister, Virchow, and Cohnheim; and that all we really know as to the nature of fever is built on the similar researches of Bernard, Haidenhain, Wood, and others. As to therapeutics, so far as giving doses of medicine is concerned, it, still in its very infancy, had its birth as an exact science in physiological laboratories. Every modern text-book on the subject gives an account of the physiological action of each drug. What the future may have in store for us by pursuit of such inquiries it is hard to limit. The work of Bernard,—showing that in curari we had a drug that would pick out of the whole body, and act upon, one special set of tissues, the endings of the nerve-fibres in muscle,—and the results of subsequent exact experiments as to the precise action of many drugs upon individual organs or tissues, hold out before us a hope that, perhaps at no very distant day, the physician will know exactly, and in detail, what every drug he puts into his patient is going to do within him.

Pathology and therapeutics, while almost essential branches of physiological inquiry, have nevertheless their own special aims; and, now that the physiologists have proved that it is possible to study these subjects experimentally, special laboratories for their pursuit are being erected in Germany, France, and England. These laboratories are stocked with physiological instruments, and carry on their work by physiological methods. Those who guide them, and those who work in them, must be trained physiologists: if not, the whole business often degenerates into a mere slicing of tumors and putting up of pickled deformities: pathological anatomy is a very good and very important thing in itself, but it is not *pathology*. Looking at the vast field of pathological and therapeutic research open to us, and bearing in mind the certainty of the rich harvest for mankind which will reward those who work on it, I believe it one of my chief duties to prepare in sound physiological doctrine and a knowledge of the methods of experiment, students who will afterwards enter laboratories of experimental pathology and pharmacology immediately connected with a medical school.

If the relations of the biological sciences to medicine be such as I have endeavored to point out, what place should they occupy in the medical curriculum? That men fitted for research, and with opportunity to pursue it, should be trained to that end, is all well and good; but how about the ninety per cent who want simply to become good practitioners of medicine? What relation is this laboratory to hold to such men, who may come to it, intending afterwards to enter a medical school? As a part of their general college-training, affording that education of a gentleman which every physician should possess, it should give a sound knowledge of the general laws which govern living matter, without troubling students with the minutiae of systematic zoölogy or botany; it should enable them to learn how to dissect, and make them well acquainted with the anatomy of one of the higher animals; it should teach them how to use a microscope; and the technique of histology; and finally, by lectures, demonstrations, and experiment, make known to them the broad facts of physiology, the means by which those facts have been ascertained, and the basis on which they rest. The student so trained, while obtaining the mental culture which he would gain from the study of any other science, is especially equipped for the study of medicine. Taught in other parts of his general collegiate course to speak and write his own language correctly, having acquired a fair knowledge of mathematics and Latin, able to read at least French and German, having learned the elements of physics and chemistry, and in addition, having studied the structure and properties of the healthy body, he can, on entering the technical school, from the very first turn his attention to professional details. Knowing already the anatomy of a cat or a dog, he knows a great part of human anatomy, and need do little but acquaint himself with the surgical and medical anatomy of certain regions. Knowing normal histology, he can at once turn his attention to the microscopy of diseased tissues. Well instructed in physiology, he can devote himself to its practical applications in the diagnosis and treatment of disease. The demand for an improvement in medical education, which has been so loudly heard in England and this country for some years, is (the more I think of it, the more I feel assured) to be met, not, as has been the case in England, by putting more general science into the medical curriculum, but by confining that curriculum to purely professional training, and providing, as we have attempted to do here, non-technical courses for undergraduates, which, while forming part of a liberal education, also have a distinct relation to their future work. I regard it as the most important of my duties, to prepare students to enter medical schools in this city or elsewhere.

To advance our knowledge of the laws of life and health; to inquire into the phenomena and causes of disease; to train investigators in pathology, therapeutics, and sanitary science; to fit men to undertake the study of the art of medicine,—these are the main objects of our laboratory. I do not know that they can be better summed up than in the words of Descartes, which I would like to see engraved over its portal: "If there is any means of getting a medical theory based on infallible demonstrations, that is what I am now inquiring." (*Reprinted from Science, January* 18, 25, 1884).

CHESAPEAKE ZOÖLOGICAL LABORATORY.

Report of the Director for its first six years, 1878-83.

To the President of the Johns Hopkins University:

SIR: In accordance with your request to prepare an outline or summary of the work of the marine laboratory during the six years of its existence, I have the pleasure to submit in connection with the report of the sixth session, the following review of the history of the five preceding years.

FIRST YEAR, (1878), AT FORT WOOL, VA.

In 1878, the Trustees of the Johns Hopkins University made a small appropriation, in order to enable a party of biological students to spend a few weeks at the seashore in the study of marine zoölogy under my direction. Permission was given us by the Secretary of War, through the influence of Maj. Gen. Q. A. Gillmore, to occupy the vacant buildings at Fort Wool. Prof. Spencer F. Baird also exerted his influence with the Secretary of War in our behalf, and aided us in many other ways; furnishing us with dredging apparatus and with three small row boats, which were used during the summer. The vacant buildings at Fort Wool were not sufficient for our accommodation, as only one of them was in sufficiently good repair for use, and the watchman in charge of the fort, Mr. Allen, readily consented to vacate for us all but one of the rooms in his house, and much of the success of our first season was due to his interest in our work.

Three students, who were not connected with the University, asked for permission to join our party, which, with these additions, consisted of eight persons, and we remained at the fort for seven weeks.

The scientific results of our season's work were printed in an illustrated volume, the cost of publishing which was born by citizens of Baltimore, among whom were Samuel M. Shoemaker, John W. Garrett, John W. McCoy, Enoch Pratt, P. R. Uhler, President Gilman, Professor Martin, and others.

Among these papers the most noteworthy were one on the "Development of Lingula" and one on the "Early Stages of Squilla." Both of these papers were reprinted in foreign journals, and their contents have since been incorporated in the best foreign text-books of zoölogy, such as Claus' "Zoölogie" and Balfour's "Comparative Embryology."

SECOND YEAR, (1879), AT CRISFIELD, MD., AND FORT WOOL, VA.

The appropriation for the maintenance of the laboratory was continued by the Trustees of the University for the next year.

In order to present an opportunity for studying the oyster beds of the Bay, and thus secure the coöperation of Maj. Ferguson, Assistant U. S. Fish Commissioner, I determined to open the laboratory at Crisfield, a point which is unfavorable in most other respects. The laboratory was accordingly opened at Crisfield on the 25th of June in three of the barges of the Maryland Fish Commission.

I stated in the preliminary announcement that the laboratory would be moved to some more desirable locality farther down the Bay, about July 10, but the transportation of the barges was attended with so much expense that I was not able to move them to the second station, and we occupied them at Crisfield until August 8. During part of this time, Maj. Ferguson's steam yacht, the Lookout, which he had fitted up with steam dredging apparatus for the purpose, was with us, and rendered valuable help in dredging and collecting. Through Maj. Ferguson's influence we also had the use of a small steam launch which was detailed for the purpose from the U. S. Navy.

Early in August the mosquitoes became so numerous as to render the barges uninhabitable, and we transferred our outfit to our old quarters at Fort Wool, which had again been placed at our service by Maj. Gen. Q. A. Gillmore, U. S. A., and where Mr. Allen again placed his private quarters at our service.

At the beginning of this session, which lasted for eleven weeks, a circular was issued by the University inviting other naturalists to avail themselves of our facilities, upon the payment of a small fee, and some of our party of twelve were persons who came from other institutions.

Among the more important of the published results of this season's work were a paper on the Development of the Oyster, one on the Metamorphosis of Phornis, one on the Development of the Squid, and one on the Metamorphosis of Panopæus.

THIRD, FOURTH, AND FIFTH YEARS, (1880–82), AT BEAUFORT, N. C.

The next year, the Trustees of the University voted to continue the laboratory for three years more, and they provided a liberal annual appropriation for the current expenses, and they also voted that the sum of $4,500 be appropriated for the purchase of outfit, &c. After an examination of all the available localities, the town of Beaufort, N. C., about four hundred miles south of Baltimore, was selected as the site for the laboratory, and as a vacant house, suitable for the accommodation of a small party, was found there, it was rented for three years, and as none of the $4,500 was needed for the erection of a building, most of it was used, by the permission of the Trustees, in the purchase of two boats, for collecting. One of these, a Herreshoff launch, twenty-seven feet long, and eight feet beam, was built for us in 1880, and the second, a sloop forty-seven feet long and fourteen feet beam, was purchased in the summer of 1883.

The natural advantages of Beaufort are very great, as the fauna is exceptionally rich and varied, abounding in forms which are of peculiar interest.

The configuration of our coast line is such that Cape Hatteras, the most projecting point south of New York, deflects the warm water of the Gulf Stream away from the coast, and thus forms an abrupt barrier between a cold northern coast and a warm southern one. The fauna north of this barrier passes gradually into that of Southern New England, while the fauna south of the barrier passes without any abrupt change into that of Florida, but the northern fauna is sharply separated by Cape Hatteras from the southern.

As the laboratory of the U. S. Fish Commission and Mr. Agassiz's laboratory at Newport afford opportunities for work upon the northern fauna, it seemed best for us to select a point south of Cape Hatteras in order to study the southern fauna with the same advantages, and as Beaufort is the only town near the Cape which can be reached without difficulty, it was chosen as the best place for the laboratory.

The situation of this town is exceptionally favorable for zoölogical work, for the surrounding waters present such a diversity of conditions that the fauna is unusually rich and varied.

Close to the town there are large sand bars, bare for miles at low tide, and abounding in animal life. From these we could collect an unfailing supply of Amphioxus, Renilla, Limulus, Balanoglossus, Sea Urchins, and a great variety of Molluscs and Crustacea.

The mud flats furnished us with another fauna, and yielded a great variety of Annelids, a new set of species of Crustacea and Molluscs, Gephyreans, Echinoderms, and Polyps. The large salt marshes gave us a third fauna, and a short distance inland large swamps of brackish and fresh water furnished still other conditions of life.

As the town is situated at the point where Gore Sound connects Pamlico Sound with Bogue Sound, we were within easy reach of a continuous sheet of landlocked salt water more than a hundred miles long, and these Sounds furnished still another collecting and dredging ground, abounding in Corals, Gorgonias, Ascidians, Star Fish, Sea Urchins, and a new set of Molluscs and Crustacea.

As most of the shores are flat and sandy those animals which live upon a sandy bottom are much more abundant than those which attach themselves to solid bodies, but the stone breakwaters at Fort Macon, the wharves at Beaufort and Morehead City, and the large oyster beds which are found in the Sounds furnish a proper habitat for many fixed animals, and yielded us a rich supply of Hydroids, Corals, Ascidians, Sea Anemones, Sponges, Cirripeds, &c. The ocean beach within a short distance of the town furnished still another fauna, and a sail of three miles from the laboratory carried us to a good locality for ocean dredging.

The greatest advantage of the locality is the richness of its pelagic fauna. There are very few points upon land which are so situated that the surface

animals of mid-ocean can be procured in abundance for laboratory work, and as careful work is very difficult on shipboard, a laboratory which can be supplied with a good number of living pelagic animals presents opportunities for work in an extremely interesting and almost new field.

The Gulf Stream is constantly sweeping these animals northwards along the North Carolina coast, and as the tide sets in through Beaufort Inlet into the Sounds the floating animals are carried with it. Such oceanic animals as Physalia and Porpita were frequently thrown, uninjured and in perfect health, upon the beach within twenty feet of the laboratory, and during the season we found nearly all the Siphonophora which are known to occur upon our Atlantic coast.

With all these advantages we enjoyed a mild and uniform climate which enabled us to work in perfect comfort during the hottest months of summer.

The zoölogical resources of Beaufort have not escaped the attention of American naturalists, and there are few places upon our coast, outside of New England, where more zoölogical work has been done. In 1860, Drs. Stimpson and Gill spent a season in dredging and collecting in the vicinity of Beaufort, Cape Lookout, and Cape Hatteras, and an account of their work was published in the *American Journal of Science*. Dr. Coues, who was stationed at Fort Macon during the war, occupied himself for two years in collecting the animals which are found here, and he published a series of papers on the "Natural History of Fort Macon and Vicinity" in the *Proceedings of the Academy of Natural Sciences of Philadelphia*.

These papers, which were continued by Dr. Yarrow, contain copious and valuable notes on the habits and distribution of the animals which were observed, and we found them a great help to us. These two naturalists found four hundred and eighty species of animals in the vicinity of Beaufort. Of these four hundred and eighty, two hundred and ninety-eight are vertebrates, and one hundred and eighty-two are invertebrates. Of the vertebrates twenty-four are mammals, one hundred and thirty-three are birds, twenty-seven are reptiles, six batrachians, ninety-seven fishes and eleven selachians. Of the invertebrates one hundred and forty-seven are molluscs, twenty-one are crustaceans. The list of vertebrates is very nearly complete, and we made few additions to it, but the list of invertebrates is obviously very imperfect, and, although we made no attempt to tabulate the species which we observed, there would be no difficulty in enlarging the list twenty or thirty fold.

Among other naturalists who have spent more or less time at Beaufort, I may mention Professor L. Agassiz, Professor E. S. Morse, Dr. A. S. Packard, Professor Webster, and Professor D. S. Jordan. Professor Morse procured most of the material for his well known paper on the Systematic Position of the Brachiopoda on the sand bars in Beaufort Inlet.

During the years 1880, 1881, and 1882, the laboratory at Beaufort was occupied by our party for sixty-four weeks in all, and twenty-two persons availed themselves of its facilities for research.

Among the published results of our investigations, lists of which have been printed in your annual reports, two papers deserve especial mention.

One of these, a monograph on the Development of Lucifer, has been printed with eleven quarto plates in the *Philosophical Transactions of the Royal Society*, while another on the Anatomy and Development of Renilla, with fourteen plates, is now in the press of the Royal Society, and is to appear soon.

Sixth Year, (1883), at Hampton, Va.

In the spring of 1883, the Trustees of the University voted to continue the annual appropriation for the current expenses of the laboratory for two years more.

My duties this summer as a Commissioner, appointed by the Governor of Maryland to examine the condition of the oyster beds of the State, compelled me to spend the season in the Chesapeake Bay, and the removal of the laboratory from Beaufort, N. C., where it had been for three years, was therefore decided upon.

The absence of buildings for the accommodation of our party at any suitable point upon the Bay except at Fort Wool and Hampton, restricted us to these two places in our selection of a laboratory. Application was made to the Secretary of War, through Maj. Gen. Q. A. Gillmore, for permission to occupy the buildings at Fort Wool, and this permission was granted; but upon visiting the fort I found the buildings so ruinous, and the wharf so injured by storms, that I decided that it would not be prudent for our party to spend the season there, and as Gen. S. C. Armstrong, the President of the Hampton Normal and Industrial Institute, kindly consented to permit our party to use an unoccupied building which had just been erected by the Institute as a machine shop, the second floor and attic were rented by the University for the season, and were occupied by the members of our party from May 1 to October 1.

The second floor room, which is large and well lighted, furnished ample laboratory accommodations, and the attic was used as lodgings.

The location was found to be a bad one, as the collecting grounds were distant and far apart, and the fauna was not rich, but researches were carried on upon the following subjects, among others: the anatomy and development of barnacles, the anatomy and development of crabs, the histology of Eudendrium, the anatomy and development of Balanoglossus, the development of the oyster, the anatomy of Lingula, the protozoea stage of crabs, the development of Annelids, the anatomy and development of Chrysaora, the origin of the eggs of hybrids and tunicates, the function of the semi-circular canals of sharks, and the general zoölogy of the Hydro-Medusae. Most of my own time for the last year has been given to the study of the oyster industry of Maryland, and my results will be stated in the report of the Oyster Commission, which is now in press.

Propagation of the Oyster.

During the past year experiments which have been carried on in France and in this country have resulted in the practical application of the methods of artificial oyster propagation, which were discovered at the laboratory five years ago, and the great economic importance of the subject will justify a short review of the history of these experiments.

Previously to 1879 our knowledge of the breeding habits of the oyster was entirely based upon the study of the oysters of northern Europe, and nothing whatever was known of the life history of the American oyster, as our writers had accepted without question the statements of foreign authorities. The oyster of northern Europe is hermaphrodite, and as the eggs are hatched inside the shell of the parent, and the young are thus carried and protected until they are ready to fasten themselves, good authorities had stated that it is not possible to rear oysters artificially.

In 1879, I found that the sexes are separate in the American oyster, and that the unfertilized eggs are thrown out in immense numbers into the water, where they are fertilized and develop without the need for any protection from their parents. I also showed that it is possible to fertilize the eggs artificially, and to rear the young oysters until long after they have acquired their shells, although I did not succeed in keeping them alive until they became attached. These experiments showed the perfect practicability of rearing oysters in unlimited numbers, as soon as the practical difficulties should be overcome.

A full account of my experiments and of the methods employed was published with figures of the early stages of the development of the oyster, in the first volume of the *Studies from the Biological Laboratory*.

While I was engaged in these experiments, Lieutenant Winslow, U. S. N., was engaged in surveying the oyster beds near the laboratory, which he visited in order to learn my methods. The next year, while stationed at Cadiz, Spain, he repeated the experiments with Portuguese oysters, and found that their breeding habits are exactly like those of the American species; that the sexes are separate; that the unfertilized eggs are thrown out into the water, and that the young can be reared from artificially fertilized eggs.

An account of his experiments was read before the Maryland Academy of Sciences in November, 1880, and it was afterwards published in the *American Naturalist*.

The next step which has resulted in the solution of the practical difficulties, and the rearing of oysters of economic value from artificially impregnated eggs, is due to experiments which were carried on by M. Bouchen-Brandely, under the auspices of the French Government.

In a paper, entitled "Rapport relatif à la génération et à la fécondation artificielle des huîtres, adressé au ministre de la marine et des colonies par M. Bouchen-Brandely, secrétaire du Collège de France," and published in

December, 1882, in the *Journal officiel de la République Française*, this author states that he was encouraged by the experiments which Brooks, of the Johns Hopkins University of Baltimore, had made upon *Ostrea virginica*, to attempt similar experiments with the Portuguese oyster, *Ostrea angulata*. He was ignorant of Winslow's experiments with this oyster, but after two years of experiments, he succeeded in independently establishing the fact that the sexes of the Portuguese oyster are separate; that the eggs are thrown out into the water; that the young are independent of parental protection, and that they can be reared from artificially fertilized eggs.

The methods by which he succeeded in rearing these young oysters are described in his report as follows. Two oyster planting ponds, separated from each other by a straight massive wall of earth, and having an area of about 100 metres each, and an average depth of about 1 metre, were placed in communication by means of a pipe which was closed at each end by a sponge, to filter sediment from the water and to guard against the accidental introduction of spat. The outlet from the ponds was guarded by a dam of fine sand confined between boards, and thus allowing the water to escape, but retaining the swimming embryos. Artificially impregnated eggs were then poured into the lower pond in great numbers during the latter part of June and the month of July. The pond was furnished with tiles for the attachment of the spat, and on July 24th each of these tiles was found to have, attached to its surface, twenty or thirty young oysters, about two-fifths of an inch in diameter. Finally, during the early part of October he states that he had the honor of presenting to the minister of the marine a tile, upon which two thousand young oysters could be counted, measuring from two-fifths to four-fifths of an inch in diameter.

This interesting paper, which has been translated into English by J. A. Ryder, and published in the *Bulletin of the U. S. Fish Commission* for April 19, 1883, shows the practicability of the economic application of the more purely scientific experiments which were carried on at our laboratory in 1879. The author acknowledges that he was incited by these experiments, and our own share in the work is therefore exactly what we should wish: the discovery of a new scientific truth, which has, in the hands of practical economists, contributed to the welfare of mankind.

Mr. John A. Ryder has this summer repeated these experiments in Maryland, and has shown that they are as successful here as they are in France. An account of his apparatus and of the results obtained has been published in the *Bulletin of the U. S. Fish Commission* for September 6, 1883, under the title "Rearing Oysters from Artificially Fertilized Eggs, together with notes on Pond Culture, &c.," by John A. Ryder.

SUMMARY.

During the six years of its existence, work has been carried on at the laboratory for one hundred and five weeks in all. It was attended by nine persons in 1878; by twelve in 1879; by six in 1880; by twelve in 1881; by eight in 1882; and by sixteen in 1883, thus making the total attendance sixty-three. The number of persons who have used the laboratory is only forty however, as many of them have spent two or three seasons there. One-half of the attendants were members of the Johns Hopkins University, and the rest were then or now connected with the Smithsonian Institution; the United States Fish Commission; the Academy of Natural Sciences, Philadelphia; University of Cambridge (St. John's College), England; the Ontario Agricultural College, Canada; or with the American colleges and schools indicated in the subjoined roll.

The scientific papers which have been published by our party, based wholly or in part upon the work done at the laboratory, include fifty-five titles, and they have been printed in the following journals: *Studies from the Biological Laboratory; Johns Hopkins University Circulars; American Naturalist; American Journal of Science; Memoirs of the Boston Society of Natural History; Zoölogischer Anzeiger; London Quarterly Journal of Microscopical Science; Proceedings and Philosophical Transactions of the Royal Society*, London. Many of the papers have been reprinted, or summarized in foreign journals, but translations and summaries are not included in the enumeration given above.

A medal of the first class of the Société d'Acclimatation of Paris and one of the Walker Prizes of the Boston Society of Natural History have been awarded to members of our party for work which was done at the laboratory.

Within the last year Professor Mitsukuri, a naturalist who received his training in zoölogical research at our marine laboratory, has organized a similar laboratory on the coast of Japan, as a branch of the Government University of Tokio.

Yours respectfully,

W. K. BROOKS,
Director Chesapeake Zoölogical Laboratory.

BALTIMORE, *January*, 1884.

ROLL OF THE CHESAPEAKE ZOÖLOGICAL LABORATORY, 1878–83.

Director.

W. K. BROOKS, Ph. D.

Members.

J. E. ARMSTRONG, *Assistant in Natural History, Illinois Industrial University.* (*1881.*)
B. W. BARTON, M. D., *Baltimore.* (*1879.*)
W. BATESON, *St. Johns College, University of Cambridge, England.* (*1882.*)
EMIL BESSELS, M. D., *Smithsonian Institution.* (*1879.*)
E. A. BIRGE, *Professor of Zoölogy, University of Wisconsin.* (*1879.*)
S. F. CLARKE, Ph. D., *Professor of Natural History, Williams College.* (*1879, '81.*)
BUEL P. COLTON, A. B., *Teacher, Natural Science, Princeton (Ill.) High School.* (*1881.*)
H. W. CONN, A. M., *Johns Hopkins University.* (*1882, '83.*)
CHARLES EARLE, *New York.* (*1883.*)
H. C. EVARTS, M. D., *Philadelphia.* (*1879, '80.*)
H. GARMAN, *Assistant, Illinois State Laboratory of Natural History.* (*1883.*)
O. P. JENKINS, A. M., *Johns Hopkins University.* (*1883.*)
J. W. KING, *Professor of Natural Science, Wisconsin State Normal School.* (*1880.*)
F. S. LEE, A. M., *Johns Hopkins University.* (*1883.*)
K. MITSUKURI, Ph. D., *Professor of Zoölogy, University of Tokio, Japan.* (*1879, '80.*)
J. PLAYFAIR MCMURRICH, *Assistant in Biology, University of Toronto.* (*1881, '83.*)
T. W. MILLS, M. D., *Montreal, Quebec.* (*1883.*)
H. F. NACHTRIEB, S. B., *Johns Hopkins University.* (*1883.*)
W. L. NORRIS, *Arlington, Ill.* (*1881.*)
E. A. NUNN, *Professor of Biology, Wellesley College, Mass.* (*1879.*)
H. L. OSBORN, A. B., *Johns Hopkins University.* (*1882, '83.*)
HENRY F. OSBORNE, A. B., *Fellow, College of New Jersey.* (*1880.*)
J. H. PILLSBURY, *Professor of Natural Science, Springfield (Mass.) High School.* (*1882, '83.*)
H. J. RICE, M. S., *Teacher of Natural Science, Brooklyn, N. Y.* (*1879, '81.*)
FERNANDO SANFORD, *Professor, Natural Sciences, Mount Morris College, Ill.* (*1881.*)
AUGUST SCHMIDT, *Teacher of Natural Science, Baltimore.* (*1878, '79.*)
H. SEWALL, Ph. D., *Professor of Physiology, University of Michigan.* (*1878, '81, '83.*)
C. SIHLER, Ph. D., *Physician, Cleveland, Ohio.* (*1878, '79.*)
W. E. STRATTON, A. B., *Johns Hopkins University.* (*1883.*)
A. H. TUTTLE, S. B., *Professor of Zoölogy, Ohio State University, Columbus, Ohio.* (*1883.*)
JOHN M. TYLER, A. B., *Professor of Zoölogy, Amherst College.* (*1882.*)
P. R. UHLER, *Associate in Natural History, J. H. U.* (*1881.*)
N. B. WEBSTER, *Principal, Military Academy, Norfolk, Va.* (*1878.*)
T. B. WEBSTER, *Teacher, Military Academy, Norfolk, Va.* (*1878.*)
E. B. WILSON, Ph. D., *Lecturer on Biology, Williams College.* (*1879–82.*)
H. V. WILSON, A. B., *Johns Hopkins University.* (*1883.*)
J. M. WILSON, M. D., *Ann Arbor, Mich.* (*1882.*)
FRANCIS WINSLOW, *Lieut. United States Navy, United States Fish Commission.* (*1882, '83.*)

Published Results of Scientific Research at the Chesapeake Zoölogical Laboratory, 1878–83.

W. K. Brooks, Ph. D.:

The Development of Lingula and the Systematic Position of the Branchiopods. (*Scientific Results, Chesapeake Zoöl. Lab.*, 1879; *Arch. f. Zoöl. exp.*, 1881.)
The Larval Stages of Squilla empusa. (*Scientific Results, Chesapeake Zoöl. Lab.*, 1879.)
Abstract of Observations on the Development of the American Oyster. (*Zoöl. Anzeiger*, 1879.)
The Artificial Fertilization of Oyster Eggs and the Propagation of the American Oyster. (*Am. Jour. of Science*, 1879.)
The Development of the American Oyster. (*Report of the Maryland Fish Commission, and Studies from the Biol. Lab., J. H. U.*, 1880.)
The Acquisition and Loss of a Food Yolk in Molluscan Eggs. (*Studies from the Biol. Lab., J. H. U.*, 1880; 10 *plates.*)
The Development of the Cephalopoda and the Homology of the Cephalopod Foot. (*Am. Jour. of Science*, 1880.)
The Rhythmical Character of Segmentation. (*Am. Jour. of Science*, 1880.)
Budding in Free Medusæ. (*Am. Nat*, *Sept.*, 1880.)
Embryology and Metamorphosis of the Sergestidæ. (*Zoöl. Anzeiger, Nov.*, 1880.)
The Young of the Crustacean Lucifer, A Nauplius. (*Am. Nat., Nov.*, 1880.)
The Development of the Squid. (*Anniv. Mem., Boston Soc. Nat. Hist., March*, 1881; 3 *plates.*)
Alternation of Periods of Rest with Periods of Activity in the Segmenting Eggs of Vertebrates. (*Studies from the Biol. Lab., J. H. U.*, 1881; 1 *plate.*)
The First Zoea of Porcellana. (With E. B. Wilson; *Studies from the Biol. Lab., J. H. U.*, 1881; 2 *plates.*)
List of the Medusæ of Beaufort, N. C. I. (*Studies from the Biol. Lab., J. H. U.*, 1882.)
Origin of the Eggs of Salpa. (*Studies from the Biol. Lab., J. H. U.*, 1882; 1 *plate.*)
Lucifer: A Study in Morphology. (*Proc., Royal Soc., London*, 1881.)
The Development of Lucifer. (*Phil. Trans. Royal Soc., London*, 1882; 11 *plates.*)
Handbook of Invertebrate Zoölogy. (*Boston, Cussino*, 1882.)
Chamisso and the Discovery of Alternation of Generations. (*Zoöl. Anzeiger*, 1882.)
The Development of the Digestive Tract in Molluscs. (*Proc., Boston Soc. Nat. Hist.*, 1879.)
The Metamorphosis of Alpheus. (*Univ. Circular, No.* 17.)
The Metamorphosis of Penæus. (*Univ. Circular, No.* 19.)
On the Origin of Alternation of Generations in Hydro-Medusæ. (*Univ. Circular, No.* 22; *Ann. of Nat. Hist.*, Vol. 11, p. 455.)
Notes on the Medusæ of Beaufort, N. C. II. (*Studies from the Biol. Lab., J. H. U.*, 1883.)
The Law of Heredity. (*Baltimore, Murphy*, 1883.)

W. Bateson:

Abstract of Observations on the Development of Balanoglossus. (*Univ. Circular, No.* 27.)

H. G. Beyer, M. D.—(See H. W. Conn.)

E. A. Birge:

Notes on the Development of Panopæus Sayi. (*Studies from the Biol. Lab., J. H. U.*, 1883, 4 *plates.*)

S. F. Clarke, Ph. D.:

New Hydroids from Chesapeake Bay. (*Boston Soc. Nat. Hist.*, 1882.)

B. P. Colton, A. B.—(See H. Garman.)

H. W. Conn, A. M.:

Development of Tubularia Cristata. (*Univ. Circular, No.* 17.)
On Radial and Bilateral Symmetry in Animals. (*Univ. Circular, No.* 22; *Ann. of Nat. Hist.*, Vol. 12, p. 69; *Journal Royal Mic. Soc.*, Vol. 3, p. 633.)
An Instance of Sexual Variation in the Crustacea. (*Univ. Circular, No.* 27.)
Evidence of a Protozoea Stage in Crab Development. (*Univ. Circular, No.* 28.)
The Nervous System of Porpita. (With H. G. Beyer. *Studies from the Biol. Lab. J. H. U.*, 1883, 1 *plate.*)
Evolution of Decapod Zoea. (*Science, April*, 1884, *in press.*)
Significance of the Larval Skin of Decapods. (*Studies from the Biol. Lab., J. H. U.*, 1884, 2 *plates.*)
Life History of Thalassema. Abstract. (*Studies from the Biol. Lab., J. H. U.*, 1884, 1 *plate.*)

H. Garman:

List of a few additions to the Species of Birds, Reptiles, and Batrachians mentioned in Dr. Elliott Coues' paper on the Natural History of Fort Macon and Vicinity. (*Univ. Circular, No.* 22.)
Development of Arbacia punctulata. (With B. P. Colton. *Studies from the Biol. Lab., J. H. U.*, 1881.)

J. P. McMurrich:

Origin of the so-called Test Cells in the Ascidian ovum. (*Studies from the Biol. Lab., J. H. U.*, 1882.)
Abstract of Observations on the Osteology and Development of Syngnathus Peckeanus (Storer.) (*Univ. Circular, No.* 27.)
On the Osteology and Development of Syngnathus Peckeanus (Storer.) (*Quart. Journal Micros. Science, Vol. XXIII*, 2 *plates.*)

K. Mitsukuri, Ph. D.:

On the Structure and Significance of some Abberant Forms of Lamellibranchiate Gills. (*Quar. Jour. Micros. Sci., July*, 1881; *Studies from the Biol. Lab., J. H. U.*, 1882.)

H. L. Osborn, A. B.:

The Structure and Growth of the Shell of the Oyster. (*Studies from the Biol. Lab., J. H. U.*, 1882, 1 *plate.*)
On the Growth of the Molluscan Shell. (*Univ. Circular, No.* 27; *Ann. of Nat. Hist. Vol.* 11, *p.* 149; *Am. Nat., Vol.* 17, *p.* 96; *Journal Royal Micros. Soc., Vol.* 3, *p.* 195.)
Of the Gill in some forms of Prosobranchiate Mollusca. (*Studies from the Biol. Lab., J. H. U.*, 1884, 3 *plates.*)
—Also see J. M. Wilson.

H. Sewall, Ph. D.:

On the Equilibrium Function of the Membraneous Labyrinth in Cartilaginous Fishes. (*Univ. Circular, No.* 12; *Journal of Physiology, Vol. IV, No.* 6, 1884.)

P. R. Uhler:

List of Animals observed at Fort Wool, Va. (*Studies from the Biol. Lab. J. H. U.*, 1879.)

N. B. Webster:

Partial List of Land Plants at Fort Wool, Va. (*Studies from the Biol. Lab., J. H. U.*, 1879.)

E. B. Wilson, Ph. D.:

The Early Stages of Renilla. (*Am. Jour. of Science*, 1880.)
Origin and Significance of the Metamorphosis of Actinotrocha. (*Quar. Jour. of Micros. Sc., April*, 1881, 2 *plates*; *Abstract in Am. Nat.*, 1882.)
The First Zoea of Porcellana. (With W. K. Brooks; *Studies from the Biol. Lab., J. H. U.*, 1881, 2 *plates.*)
Observations on the Early Developmental Stages of some Polychætous Annelides. (*Studies from the Biol. Lab., J. H. U.*, 1882; *Abstract in Zoöl. Anzeiger*, 1880, *and in Am. Jour. of Science*, 1880.)
A New Species of Pilidium. (*Studies from the Biol. Lab., J. H. U.*, 1882.)
Abstract of Observations on the Structure and Development of Renilla and Leptogorgia. (*Univ. Circular, No.* 17.)
The Development of Renilla. (*Proc., Royal Soc., London, No.* 222; *Univ. Circular, No.* 22.)
—Also see J. M. Wilson and W. K. Brooks.

J. M. Wilson, M. D.:

Variation in the Segmentation of the Egg of Renilla. (With E. B. Wilson and H. L. Osborn; *Zoöl. Anzeiger*, 1882, No. 123; *Archiv f. Zoöl. exper.*, 1883.)

Dr. E. B. Wilson's monograph on the Development of Renilla is now in print, and it will soon appear with sixteen quarto plates, in the *Philosophical Transactions of the Royal Society*. Several other papers are now ready for publication. One of these, a paper on the Development of Thalassema, by Mr. H. W. Conn, has received one of the Walker prizes of the Boston Society of Natural History.

STUDIES FROM THE BIOLOGICAL LABORATORY.

(*Including the Chesapeake Zoölogical Laboratory.*).

The *Studies from the Biological Laboratory* are published under the direction of Professor Newell Martin, Editor, and Dr. W. K. Brooks, Associate Editor. Two volumes have been issued: Vol. I (1879–80), 500 pp., 40 plates; Vol. II (1881–83), 496 pp., 37 plates.

Vol. III., No. 1, is now ready. It contains papers on:

The Significance of the Larval Skin of Decapods. (27 pp., 2 plates). By H. W. Conn.

Life History of Thalassema. (7 pp., 1 plate). By H. W. Conn.

Of the Gill in some forms of prosobranchiate Mollusca. (12 pp., 1 plate). By H. L. Osborn.

The "*Studies*" contain the majority of the original scientific papers published by members of the Biological Department of the University.

In future they will appear in numbers issued at intervals as material for publication is ready. To each of these numbers will be affixed a price dependent on its size and the number and cost of plates printed with it. These numbers may be purchased separately or all of them will be forwarded as published to persons who subscribe in advance for the whole volume. The subscription price for the volume of about 500 pages, postage prepaid, is $5.00. Price of Vol. III, No. 1, 70 cents.

As in future no articles will be reprinted from the *Journal of Physiology*, the "*Studies*" will no longer be sold at a reduced price to the subscribers to that Journal.

Remittances and propositions for exchange should be addressed to the "Publication Agency of the Johns Hopkins University."

CURRENT INTELLIGENCE.

Lectures on Physics by Sir William Thomson.

Sir William Thomson, D. C. L., F. R. S. L. & E., etc., Professor of Physics in the University of Glasgow, will deliver in October next, a course of eighteen lectures on *Molecular Dynamics*, before the students in Physics of the Johns Hopkins University.

An introductory lecture will be given on Wednesday, October 1. The other lectures will follow on consecutive days.

These lectures are intended only for students who are interested in advanced work. Professors and students of physics are invited to attend, and arrangements will be made by which they may easily obtain temporary lodgings, provided an early intimation is received of their intention to come. A registration fee of $5 will be required.

Professorship of Psychology.

Dr. G. Stanley Hall, well-known as a writer and lecturer on philosophical and educational subjects, has been appointed Professor of Psychology and Pedagogics in this University. Dr. Hall was graduated at Williams College, and at a later day received the degree of Doctor of Philosophy from Harvard College, and afterwards prosecuted his studies in Germany under Zeller, Trendelenberg, Ludwig, and Wundt. His lectures have been sought for in many colleges, and his cooperation in educational associations has been highly prized. He has written for the *Princeton Review*, for *Mind*, for the *Nation*, and for other periodicals,—and many of his papers were collected and published in a separate volume. He is now engaged in prolonged inquiries respecting the education of young children and the methods of teaching philosophy, from which important results are anticipated. He has also been deeply engaged in psycho-physic researches soon to be published. Convenient rooms and suitable apparatus have been provided for this work.

Professorship of Pathology.

Dr. William H. Welch, a graduate in Arts of Yale College, and in Medicine of the College of Physicians and Surgeons in New York, has been appointed Professor of Pathology in the medical faculty of this University. Dr. Welch is now Professor of Pathological Anatomy and General Pathology in the Bellevue Hospital Medical College of New York, and has given evidence of his ability as an independent investigator, and as a skilful teacher.

New Regulations as to the Degree of Doctor of Philosophy.

The degree of Doctor of Philosophy and Master of Arts will be conferred hereafter on the following conditions:

1. The candidate must for three years pursue university studies under conditions approved by the Board of University Studies, of which the last year must be as a matriculated graduate student in the philosophical department of this university.
2. He must satisfy the Board of University Studies as to his attainments by the preparation of a thesis and by passing written and oral examinations in one principal and two subsidiary subjects approved by the Board.
3. Unless permission to the contrary be given, the thesis must be presented at least three months before the candidate intends to take his degree.
4. The examination shall take place after the thesis has been approved; the oral part of it before the Board of University studies.
5. The above regulations as to the degree of Doctor of Philosophy and Master of Arts abrogate all previous announcements incompatible with them, with this exception: graduate students now on the roll and accepted as candidates for the degree before the close of the current academic year will be examined under the regulations hitherto in force.

An excursion map of Baltimore and its neighborhood for the use of the students of the University is now in preparation. A statement of its plan is given by Mr. A. L. Webster on page 80 of this *Circular*.

PUBLIC LECTURES.

XIII. ENGLISH LITERATURE.

Dr. H. Wood, Associate of the Johns Hopkins University, will give a course of eight lectures on *English Literature in the period from* 1500 *to* 1580 *A. D.*, beginning Friday, April 18, 1884, in Hopkins Hall.

The lectures will be given at 5 p. m., on Mondays, Wednesdays, and Fridays.

1. *Friday, April* 18. The literary traditions of Henry the Seventh's time, and the new age: Lord Berners, Stephen Hawes.
2. *Monday, April* 21. The highest bloom of the old culture: Sir Thomas More.
3. *Wednesday, April* 23. The conservative thinker and the folk-preacher: John Fisher, Hugh Latimer.
4. *Friday, April* 25. The tradition of native poetry under the stimulus of the Renaissance: Skelton, Dunbar, Lyndesay.
5. *Monday, April* 28. The foreign literary spirit: Surrey and Wyatt, Tottel's Miscellany; Translations from contemporary literature; The novels.
6. *Wednesday, April* 30. The poets of high seriousness: Sackville, Gascoigne.
7. *Friday, May* 2. The translators from Greek and Latin, and the revivers of the classic drama: Golding, Gascoigne, Phaer, Stanyhurst, Surrey, North.
8. *Monday, May* 5. The beginnings of the true English drama: Ralph Roister Doister, Gammer Gurton's Needle, Gorboduc.

XIV. ON THE "TEACHINGS OF THE APOSTLES."

Mr. J. Rendel Harris, Lecturer on New Testament Greek, gave three lectures on the newly published tract entitled "*The Teachings of the Apostles*," in Bentley Hall, on April 1, 3, and 5.

The following topics were taken up:

I. Introduction; Narrative of the Discovery and Publication; Authenticity; Relation to Second Century Literature.

II. The Text itself.

III. The Bearing of this Discovery.

BIBLIOGRAPHY.

1. Bryennios' edition, (Greek text, with prolegomena and notes). Constantinople, 1883. 8o.
(An early copy of this was courteously placed at the disposal of the Johns Hopkins University by Rev. Dr. C. R. Hale.)
2. Harnack has given a translation in the Theologische Literaturzeitung. (No. 3, 1884.)
3. The text and translation edited by Professors Hitchcock and Brown of the Union Theological Seminary. Scribners. N. Y. 1884. Price 50 cents.
4. The Andover Review, April, contains a critique by Professor E. C. Smyth, and a translation by Rev. C. C. Starbuck.
5. Editorial articles in "The Independent," especially of February 28 and March 6.

PROCEEDINGS OF SOCIETIES.

Scientific Association.

March 5.—Fifty-sixth regular meeting. Professor Martin in the chair. Twenty-five members present.

Papers read:

On the Glucose Industry in the United States, by I. Remsen.

On the Gastropod Gill, by H. L. Osborn.

On a Case of Endocarditis in a Dog, by W. T. Councilman.

April 2.—Fifty-seventh regular meeting. Professor Martin in the chair. Twenty members present.

Papers read:

On Compound Reaction Time, by G. Stanley Hall.

On the Coagulation of the Blood, by W. H. Howell.

Philological Association.

March 7.—Fifty-third regular meeting. Professor Gildersleeve in the chair. Thirty-three members present.

Papers read:

On Uniformity and Analogy, by Professor M. W. Easton of the University of Pennsylvania, presented and criticised by M. Bloomfield. (*Abstract on p.* 73).

On the Nahuatl Spanish Dialect of Nicaragua, by A. M. Elliott. (*Abstract on p.* 74).

April 4.—Fifty-fourth regular meeting. Professor Gildersleeve in the chair. Thirty-five members present.

Papers read:

On Rhythmical Pronunciation of Greek and Latin Prose and a few remarks on Accent, by C. W. E. Miller.

On Parallelisms in Beowulf, by C. B. Wright.

Historical and Political Science Association.

February 29.—Dr. H. B. Adams in the chair.

Luther Martin, a Biographical Study, by H. P. Goddard.

Martin was for fifty years the leader of the Maryland bar and twice held the office of Attorney General. A bitter opponent of the Constitution in 1787, he afterwards became a strict constructionist and an advocate of State's rights. He was one of the counsel for the defence in the trials of Judge Chase and Aaron Burr. In 1822 the latter took Martin to his own home in New York, where the once brilliant Maryland advocate died, a mental wreck, in 1826, at the age of 78.

March 7.—Dr. H. B. Adams in the chair.

The Development of the Passover Scandal, by J. Rendel Harris.

The paper established the historical continuity of the calumnies concerning the use of human flesh and blood at religious banquets from the times of the early Christians down to the persecuted Jews in modern Hungary. The charges made by Jews and Pagans against Christians were subsequently transferred by the latter and made against herectical sects, *e. g.*, the Montanists, and, in the course of the middle ages, these charges were brought home to the Jews. Almost every Christian nation has had some legend of child-sacrifice by the Jews like that illustrated by Hugh of Lincoln.

March 14.—Dr. R. T. Ely in the chair.

Moses as a Statesman, by John Dunlap, Esq., of Richmond, Va.

This paper related to Hebrew civic, religious, and military institutions, to penal law, administration, etc.

March 21.—Dr. H. B. Adams in the chair.

Additional Notes on Icaria, by Albert Shaw. (*Abstract on p.* 77).

Rudimentary Society among Boys. Part I. Land Tenure, by John Johnson.

Review of the American edition of Laveleye's Elements of Political Economy, edited by Dr. Taussig, by R. T. Ely.

Review of the Hon. A. C. Goodell's monographs on the History of Witchcraft, the Seals of Massachusetts, etc., by J. F. Jameson.

March 28.—Dr. H. B. Adams in the chair.

Tammany Hall, a Study of New York City Politics, by Talcott Williams, of *The Press*, Philadelphia.

April 4.—Dr. H. B. Adams in the chair.

Old Teutonic Life in Beówulf, by James A. Harrison.

The paper is an attempt to reconstruct an outline of Old Teutonic life as contained in *Beówulf*, a poem of the eighth or ninth century written in Anglo-Saxon. Though the texture of the poem is Dano-Scandinavian, this poem was found to contain much that could be called in general Teutonic; it is filled with folk-lore, superstitions, customs, traces of ancient, and foreshadowings of modern life; a reservoir of dynastic traditions and legends very valuable to the student of the origins of Germanic history.

Samuel Adams, the Man of the Town-Meeting, by James K. Hosmer.

Society for Semitic Philology.

December 13.—First meeting. Professor Haupt in the chair. Seven members present.

Papers read:

The City of Harran and its Place in Ancient History, by C. Adler.

Harran and its Condition after the Christian Era, by A. L. Frothingham Jr.

The People and Language of the Medes founded on Delattre "Le Peuple et l'Empire des Mèdes," by C. Lehmann.

An etymology of the Name of S. Luke given by Isidore of Seville, by J. Rendel Harris.

Dr. A. L. Frothingham Jr., was elected Secretary.

January 18.—Second meeting. Professor Haupt in the chair. Eight members present.

Papers read:

The Differences in the Pronunciation of many Letters in Hebrew among the Jews of different countries of Europe, by C. Adler.

The History of Syriac Literature from the beginning of the Christian Era to the period of the Mohammedan Conquest, by A. L. Frothingham Jr. (*Abstract on p.* 75).

February 28.—Third meeting. Professor Haupt in the chair. Seven members present.

Papers read:

The Massora and its Critical and Editorial Treatment, by A. H. Huizinga.

The history of Syriac Literature from the Mohammedan Conquest to its extinction in the XIII century (continued), by A. L. Frothingham Jr. (*Abstract on p.* 75).

March 17.—Fourth meeting. Professor Haupt in the chair. Nine members present.

Papers read:

The exchange of *šin* and *nun* in the Proto-Babylonian Language, by C. Lehmann.

A Hebrew MS. of C. 1300 important for its various readings of the Old Testament text, by C. Adler.

Semitic loan-words in Old Greek, by W. M. Arnolt.

Mathematical Society.

March 19.—Dr. Story in the chair. Eleven members present.

Papers read:

On a System of Straight Lines determined by two Given Lines, by W. E. Story.

A Certain Class of Transcendental Functions, by T. Craig.

A Note on Partitions, by G. S. Ely. (*Abstract on p.* 76).

Unicursal Curves in *n*-Flat Space, by G. Bissing. (*Abstract on p.* 77).

A Note on Cycles, by A. S. Hathaway.

Some Remarks on Unicursal Curves, by E. W. Davis.

Metaphysical Club.

March 11.—Thirty-seventh regular meeting. Dr. G. Stanley Hall in the chair. Sixteen members present.

Papers read:

The New Psychology, by J. Dewey.

The Body as a Spiritual Residence, by E. M. Hartwell.

Archæological Society.

March 14.—Second general meeting. Dr. Adams in the chair. Fourteen members present.

Paper:

Report on the Collection of Casts in the Peabody Institute, by L. Hoskins.

This paper was drawn up with the object of showing what field the collection covered and what opportunity for study it afforded to the Society.

Address:

On the Entasis in Greek Architecture, by J. T. Clarke. (*Abstract on p.* 83).

March 22.—Third general meeting. Professor Gildersleeve in the chair. Thirty-one members present.

Address:

On the Acropolis of Athens, by W. J. Stillman. (*Abstract on p.* 83).

Report:

On the Library of the Peabody Institute (Ancient Art), by A. Emerson.

Baltimore Naturalists' Field Club.

February 20.—Dr. G. H. Williams in the chair. Twenty members present.

Communications:

On Economic Entomology, by O. Lugger.

This paper treated of the excessive insect depredations in the United States and their causes.

On the Peculiarities of certain Linden trees on Cathedral street, by B. W. Barton.

These trees show at different heights from the pavement large swellings, the reason for which has not been clearly understood. It was shown that the swellings were caused by the grafting of the European Linden on the American bass-wood.

Mr. Bruce gave an account of the bad-lands in the south-western part of Dakota, noted for the abundance of fossil remains of extinct animals to be found there.

March 19.—Dr. G. H. Williams in the chair. Fifteen members present.

Communications:

On Insects injurious to Herbaria, by O. Lugger.

In looking over a collection of 3500 species of alpine plants of Europe presented to this University by Dr. A. F. W. Schimper, several species of injurious insects were found. Amongst them were the Sitodrepa panicea, Ptinus fur, and a very destructive species of Ptinus not found before in this country. The three species named belong to the family of Ptinidæ, popularly known as the death-watch. Two species of the apterous Psocus were also found in limited numbers.

Mr. Webster made a report on the map of the region around Baltimore which is being prepared. (*Abstract on p.* 80).

Dr. Barton read some notes in Botany. He gave an account of some yellow jessamine visited by humble bees.

The bees were unable to get at the nectar from the mouth of the corolla and were obliged to puncture it from the base. They died, however, from its effects. Several seeds were described, apparently oat-seeds, having on the back a long awn bent near the middle. The thigh of this leg-like awn was found to be spirally twisted and if held fast and moistened the seed attached was turned upon its axis. The theory was advanced that by its hygroscopic quality when the seed was dropped and covered by drifting sand and moistened by rain, the unwinding of the awn now held fast in the sand would bore the seed into the earth to a depth sufficient to insure germination.

[This Number is especially devoted to the Programmes for the Next Academic Year and to Statements of the Work of the Past Year].

JOHNS HOPKINS

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CONTENTS.

PROGRAMMES FOR 1884-85.

The following courses in literature and science are offered for the academic year which begins September 23, 1884. They are open to all properly qualified young men according to conditions varying somewhat in each department. Detailed statements as to the various subjects are given in the programmes of the departments of instruction on subsequent pages. A special Circular relating to College Courses has been issued.

The Annual Register giving detailed statements as to the regulations and work of the University will be sent on application.

B. L. GILDERSLEEVE, *Professor of Greek.*

(*a*) will direct the Greek Seminary. *Twice weekly, through the year.*
(*b*) will conduct a course of Practical Exercises in Greek. *Twice weekly, from October to January.*
(*c*) will lecture on the Greek Lyric Poets. *Weekly, after the first of January.*
(*d*) will give a course of lectures on the Syntax of the Greek Moods and Tenses.
(*e*) will hold a series of conferences on Greek Grammar. *Weekly, during the second half-year.*

G. STANLEY HALL, *Professor of Psychology and Pedagogics.*

(*a*) will lecture on Psycho-Physiology. *Twice weekly, through the year.*
(*b*) will direct the work of those engaged in Psycho-Physic research.
(*c*) will lecture on the History of Modern Philosophical and Educational Ideas. *Weekly, through the year.*
(*d*) will hold a series of conferences on Educational Topics.
(*e*) will direct the course required of matriculated students in Logic, Ethics, and Psychology.

PAUL HAUPT, *Professor of the Shemitic Languages.*

will give courses in
(*a*) Hebrew. *Four times weekly, through the year.*
(*b*) Chaldean Grammar, etc. *Weekly, through the year.*
(*c*) Ethiopic. *Weekly, through the year.*
(*d*) Arabic. *Weekly, through the year.*
(*e*) Assyrian. *Twice weekly, through the year.*
(*f*) Sumero-Akkadian. *Weekly, through the year.*

H. N. MARTIN, *Professor of Biology.*

(*a*) will direct the Laboratory Work in Biology. *Daily, through the year.*
(*b*) will lecture on Animal Physiology and Histology. *Three times weekly, through the year.*
(*c*) will lecture on General Biology. *Three times weekly, until the middle of April.*
(*d*) will lecture on the Embryology of the Chick. *Three times weekly, from the middle of April until the close of the session.*

C. D. MORRIS, *Collegiate Professor of Greek and Latin.*

will form classes in:—
(*a*) Plato, Gorgias. *Four times weekly, first half-year.*
(*b*) Aeschylus; Euripides. *Three times weekly, second half-year.*
(*c*) Cicero. *Three times weekly, first half-year.*
(*d*) Catullus; Martial. *Seven times in two weeks, second half-year.*
(*e*) Greek Prose Composition. *Weekly, through the year.*
(*f*) Reading Latin at Sight. *Weekly, through the year.*
(*g*) Latin Prose Composition. *Weekly, through the year.*
(*h*) will give a series of conferences on Greek History. *Weekly, first half-year.*

IRA REMSEN, *Professor of Chemistry.*

(*a*) will direct the Laboratory Work in Chemistry. *Daily, through the year.*
(*b*) will direct the courses of lectures to advanced students.
(*c*) will lecture on General Chemistry. *Four times weekly, first half-year.*
(*d*) will lecture on the Compounds of Carbons. *Four times weekly, second half-year.*

H. A. ROWLAND, *Professor of Physics.*

(*a*) will lecture on Electricity and Magnetism. *Four times weekly, through the year.*
(*b*) will direct a course of advanced work in the Physical Laboratory. *Daily, through the year.*
(*c*) will conduct meetings for the discussion of current Physical literature. *Weekly, through the year.*

SIR WILLIAM THOMSON, *Professor in the University of Glasgow.*

will give a course of eighteen lectures on Molecular Dynamics. *In October,* 1884.

H. B. ADAMS, *Associate Professor of History.*

(*a*) will direct the Seminary of Historical and Political Science. *Weekly, through the year.*
will give the following courses:—
(*b*) History of Politics. *Three times weekly, through the year.*
(*c*) Mediæval Church and State. *Twice weekly, first half-year.*
(*d*) the Italian Renaissance and the German Reformation. *Twice weekly, second half-year.*
(*e*) the Modern State System. *Twice weekly, through the year.*
(*f*) Introductory to the study of History. *Weekly, first half-year.*

M. BLOOMFIELD, *Associate Professor of Sanskrit.*

will give courses in :—

(*a*) Elementary Sanskrit.
(*b*) Advanced Sanskrit.
(*c*) Introduction into the Rig-Veda.
(*d*) Advanced Vedic Study.
(*e*) Introduction into Comparative Philology.
(*f*) Comparative Grammar of Greek.

W. K. BROOKS, *Associate Professor of Morphology.*

(*a*) will direct the work of the Marine Laboratory.
(*b*) will lecture on the Elements of Zoölogy.

T. CRAIG, *Associate Professor of Applied Mathematics.*

(*a*) will direct a Mathematical Seminary. *Weekly, through the year.*

will give courses in :—

(*b*) Theory of Functions including Elliptic Functions. *Three times weekly, through the year.*
(*c*) Calculus of Variations. *Twice weekly, first half-year.*
(*d*) Analytic Mechanics. *Three times weekly, first half-year.*
(*e*) Hydrodynamics. *Three times weekly, second half-year.*
(*f*) Partial Differential Equations. *Twice weekly, second half-year.*
(*g*) Total Differential Equations. *Twice weekly, through the year.*

A. M. ELLIOTT, *Associate Professor of the Romance Languages.*

(*a*) will give advanced courses in the Romance Languages. *Daily, through the year.*
(*b*) will lecture on French Philology and on French Literature of the Middle Ages.

J. RENDEL HARRIS, *Associate Professor of New Testament Greek and Palæography.*

will give courses in :—

(*a*) Palæography, with especial reference to the documents of the New Testament.
(*b*) New Testament and Patristic Greek.
(*c*) Church History.

G. S. MORRIS, *Lecturer on the History of Philosophy.*

will lecture, during the first half-year, on :—

(*a*) History of Philosophy in Greece. *Twice weekly.*
(*b*) Ethics or the Science of Man. *Twice weekly.*
(*c*) Modern Philosophy.

H. N. MORSE, *Associate Professor of Chemistry.*

(*a*) will assist in directing the Laboratory Work of the undergraduate students in Chemistry.
(*b*) will lecture on Analytical Chemistry. *Four times weekly, first half-year.*
(*c*) will conduct a course in General Chemistry. *Three times weekly, second half-year.*

L. RABILLON, *Lecturer on French Literature.*

will give a series of lectures on French Literature (in French).

W. E. STORY, *Associate Professor of Mathematics.*

(*a*) will direct a Mathematical Seminary. *Weekly, through the year.*

will give the following courses :—

(*b*) General Introductory Course for Graduates. *Five times weekly, through the year.*
(*c*) Theory of Numbers. *Twice weekly, first half-year.*
(*d*) Higher Algebra. *Twice weekly, second half-year.*
(*e*) Modern Synthetic Geometry. *Three times weekly, first half-year.*
(*f*) Quaternions. *Three times weekly, second half-year.*
(*g*) Conic Sections. *Twice weekly, through the year.*

M. WARREN, *Associate Professor of Latin.*

(*a*) will direct the Latin Seminary. *Twice weekly, through the year.*
(*b*) will give during the first half-year a course of lectures on the Roman Satirists.
(*c*) will conduct during the second half-year a series of Practical Exercises in Latin.

will form classes for undergraduates in :—

(*d*) Plautus; Terence. *Three times weekly, first half-year.*
(*e*) Tacitus. *Seven times in two weeks, second half-year.*
(*f*) Latin Prose Composition. *Weekly, through the year.*
(*g*) Reading Latin at Sight. *Once in two weeks, through the year.*

W. HAND BROWNE, *Examiner in English.*

will conduct courses in English. *Through the year.*

R. T. ELY, *Associate in Political Economy.*

will conduct courses in :—

(*a*) Finance and Taxation. *Three times weekly, through the year.*
(*b*) Comparative Studies in European Administration. *Weekly, through the year.*
(*c*) Elements of Political Economy. *Five times weekly, first half-year.*
(*d*) History of Political Economy. *Five times weekly, second half-year.*

F. FRANKLIN, *Associate in Mathematics.*

will give courses in :—

(*a*) Problems in Mechanics. *Twice weekly, through the year.*
(*b*) Differential and Integral Calculus. *Three times weekly, through the year.*
(*c*) Theory of Equations. *Three times weekly, first half-year.*
(*d*) Solid Analytical Geometry. *Three times weekly, second half-year.*
(*e*) Preparation for Matriculation in Trigonometry and Analytical Geometry.

J. F. JAMESON, *Associate in History.*

(*a*) will give a series of lessons upon the relation of Physical Geography to History.
(*b*) will teach French and English History. *Three times weekly, through the year.*
(*c*) will teach a class in the principles of the English and American Constitutions. *Three times weekly, through the year.*
(*d*) will teach a class in the history of Greece and Rome. *Twice weekly, through the year.*

A. L. KIMBALL, *Associate in Physics.*

(*a*) will direct the course of instruction for undergraduates in General Physics, including experimental lectures, recitations, etc. *Daily, through the year.*

(*b*) will give courses of lectures on selected topics to the major course students.

(*c*) will direct the work in the laboratory of the major and minor course students.

G. H. WILLIAMS, *Associate in Mineralogy.*

(*a*) will lecture on Mineralogy. *Weekly, first half-year; twice weekly, second half-year.*

(*b*) will lecture on General Inorganic Geology.

(*c*) will direct the practical work in Mineralogy and Petrography.

H. WOOD, *Associate in German.*

will conduct courses in German. *Through the year.*

A. EMERSON, *Instructor in Classical Archæology.*

will conduct courses in Classical Archæology.

E. M. HARTWELL, *Instructor in Physical Culture.*

will direct the instruction in Physical Culture.

E. H. SPIEKER, *Assistant in Greek and Latin.*

will teach undergraduate classes in Greek and Latin.

H. A. TODD, *Instructor in the Romance Languages.*

(*a*) will give instruction in French. *Daily, through the year.*

(*b*) will give instruction to special students in Italian and Spanish.

W. H. HOWELL, *Chief Assistant in Biology.*

(*a*) will direct the practical work of the undergraduate classes in Physiology and Histology.

(*b*) will give instruction in Plant Analysis.

E. H. KEISER, *Assistant in Chemistry.*

will assist in directing the work of the beginners in the Chemical Laboratory.

C. A. PERKINS, *Assistant in Physics.*

will assist in directing the work of the minor course students in Physics.

H. NEWELL, *Instructor in Drawing.*

will give instruction in free-hand and mechanical drawing, after 1 o'clock p. m. *Daily, through the year.*

C. L. WOODWORTH, *Instructor in Elocution.*

will give instruction in Vocal Culture. *Daily, through the year.*

O. LUGGER, *Curator of the Biological Museum.*

will have charge of the Museum of the Biological Laboratory.

ADMISSION OF STUDENTS.

Graduate, undergraduate, and special students are admitted to the University.

Advanced and graduate students are received with or without reference to their being candidates for a degree, and they are permitted to attend such lectures and exercises as they may individually select. They are not examined for admission to the University, but each instructor satisfies himself of the attainments of all who wish to follow his guidance before admitting them to his classes.

Undergraduate students of the following classes are received—(*a*) those who having passed a full matriculation examination are candidates for the degree of Bachelor of Arts, and who, on completing a definite amount of work in lines varying according to the needs or preferences of the student, are advanced to that degree;—(*b*) those who come with the intention of proceeding to the B. A. degree, but are from various causes unable at once to pass the examination for matriculation, and are admitted as candidates for it, if they show that their acquirements are such that they may reasonably be expected to complete the work in a moderate time;—(*c*) special students who do not aim at a university degree but desire only to prosecute one or more branches of study with the full advantages which the University affords to persons who are able to profit by them.

The next term will begin Tuesday, September 23, 1884, on which day the examinations for matriculation begin. The first week is devoted to the examination of candidates for admission and matriculation, and to the organization of classes. Instructions will be resumed Tuesday, September 30, 1884. The term of instruction closes on Friday, June 12, 1885. There will be a brief recess at the Christmas holidays and also in the early Spring.

For further information, during the summer vacation, letters should be addressed to the "Johns Hopkins University," Baltimore, Md., and not to the individual Professors, who are likely to be absent from the city.

MATHEMATICS.

PROGRAMME FOR 1884-85.

Graduate Courses.

DR. STORY:

General Introductory Course for Graduates (including Higher Algebra, Theory of Numbers, Probabilities, Higher Plane Curves, Surfaces and Twisted Curves, Quaternions, Calculus of Operations, Partial Differential Equations, Elliptic Functions, and Mechanics).
Five times weekly, through the year.
This course is intended as preparatory for all the more advanced courses, and candidates for the Doctor's degree in Mathematics are expected to take it in the first year of their candidacy, if they have not previously taken it.

Theory of Numbers.
Twice weekly, first half-year.

Higher Algebra.
Twice weekly, second half-year.

Modern Synthetic Geometry.
Three times weekly, first half-year.

Quaternions.
Three times weekly, second half-year.

Mathematical Seminary.
Weekly, through the year.
The exercises of this Seminary will consist of original work by the students, under the guidance of the Director, on a prescribed subject. After a few preparatory lectures the problem will be given to the class, and thereafter the students will be expected to make weekly reports of progress, which will be discussed, and from time to time new lines of research will be suggested. The subject for investigation in the first half of the ensuing year will be selected from the Theory of Numbers or Modern Geometry, and in the second half of the year from the Higher Algebra or Quaternions.

DR. CRAIG:

Theory of Functions (including Elliptic Functions).
Three times weekly, through the year.

Analytic Mechanics.
Three times weekly, first half-year.

Hydrodynamics.
Three times weekly, second half-year.

Calculus of Variations.
Twice weekly, first half-year.

Partial Differential Equations.
Twice weekly, second half-year.

Mathematical Seminary.
Weekly, through the year.
The subjects to which attention will be particularly directed are the Theory of Analytical Functions and Lamé's Functions. During the first two or three meetings of the Seminary the Director will occupy the hour, and after that time the students will read dissertations on subjects selected for them by the Director. The work assigned will be divided into three parts: solution of problems, the historical investigation of the above mentioned subjects, and reports on current mathematical journals.

DR. FRANKLIN:

Problems in Mechanics.
Twice weekly, through the year.

Historical Lectures on Mathematical Topics by the Instructors, Fellows, and some of the Graduate Students.
Once in two weeks, through the year.

Mathematical Society.

The Mathematical Society, composed of the instructors and advanced students, will meet monthly as heretofore for the presentation and discussion of papers or oral communications.

Undergraduate Courses.

FIRST YEAR:

Conic Sections.
Twice weekly, through the year. DR. STORY.

Differential and Integral Calculus.
Three times weekly, through the year. DR. FRANKLIN.

SECOND YEAR:

Total Differential Equations.
Twice weekly, through the year. DR. CRAIG.

Theory of Equations.
Three times weekly, first half-year. DR. FRANKLIN.

Solid Analytic Geometry.
Three times weekly, second half-year. DR. FRANKLIN.

Preparation for Matriculation in Trigonometry and Analytic Geometry.
Three or four times weekly, through the year. DR. FRANKLIN.

WORK OF THE PAST YEAR, 1883-4.

Professor Sylvester:
Algebra of Multiple Quantity. *Twice weekly, till the Christmas recess.*

Dr. Story:
Theory of Invariants. *Three times weekly, first half-year.*
Non-Euclidean Geometry. *Twice weekly, second half-year.*
Mathematical Astronomy. *Three times weekly, first half-year; twice weekly, second half-year.*
Higher Plane Curves. *Twice weekly, through the year.*
Conic Sections. *Twice weekly, through the year.*

Dr. Craig:
Theoretical Dynamics. *Twice weekly, first half-year.*
Mathematical Theory of Sound. *Three times weekly, first half-year.*
Elliptic Functions. *Three times weekly, first half-year.*
Theory of Functions. *Three times weekly, second half-year.*
Partial Differential Equations. *Twice weekly, second half-year.*
Theory of Elasticity. *Twice weekly, second half-year.*
Spherical Harmonics and Lamé's Functions. *Three times weekly, second half-year.*

Dr. Franklin:
Mechanics. *Three times weekly, through the year.*
Total Differential Equations. *Twice weekly, through the year.*
Determinants and Theory of Equations. *Three times weekly, first half-year.*
Solid Analytic Geometry. *Three times weekly, second half-year.*
Differential and Integral Calculus. *Three times weekly, through the year.*

Mr. C. S. Peirce:
Probabilities. *Twice weekly, second half-year.*

List of Papers read at the Mathematical Society.

G. Bissing.—On the degeneration of unicursal curves; a note on developable surfaces; unicursal curves in n-flat space; on curvature in n-flat space.
T. Craig.—On a certain class of transcendental functions.
E. W. Davis.—Some remarks on unicursal curves.
W. P. Durfee.—A note on the divisibility of numbers; on the number of substitutions of n letters which leave k of them unaltered.
G. S. Ely.—A note on partitions.
F. Franklin.—An elementary demonstration of Stirling's theorem; two notes.
A. S. Hathaway.—A demonstration of a theorem of Clebsch; the reduction of quadratic forms to sums of squares; on a form for the residues of composite moduli; a note on cycles.
C. S. Peirce.—On the mode of representing negative quantity in the logic of relatives.
W. E. Story.—On the intersection of linear and quadratic loci; a symbolical demonstration of Taylor's theorem; on a system of straight lines determined by two given lines; a note on ruled surfaces; on the equations which determine the directions of the axes of a quadric surface.
J. J. Sylvester.—The relation of minor determinants of products to minors of the factors.

Four numbers making the sixth volume of the American Journal of Mathematics have been issued during the academic year and the first number of the seventh volume is now in press.

PHYSICS.

PROGRAMME FOR 1884-85.

I. Advanced Course.

Professor Rowland:

Electricity and Magnetism.
Four lectures weekly.

Meetings for the Discussion of Current Literature.
Weekly.

Associate Professor Craig:

Analytic Mechanics.
Three times weekly, first half-year.

Hydrodynamics.
Three times weekly, second half-year.

Partial Differential Equations.
Twice weekly, second half-year.

Dr. Kimball:

A course of lectures adapted to the wants of those who have already taken the equivalent of the undergraduate course in General Physics, and who wish to continue their studies in Physics, while making other subjects their principal study.
Lectures weekly.

Courses of Selected Readings in Physics by the students with examinations.

Heretofore these have embraced selections from the following works, one from each group being requisite:
Sound: Helmholtz.
Heat: Maxwell, Wüllner, Verdet, Tyndall.
Electricity and Magnetism: Jenkin, Wüllner, Verdet.
Light: Wüllner, Lloyd, Daguin, Jamin, Verdet.
Conservation of Energy: Youmans, and others.

Dr. Franklin:

Problems in Mechanics.
Twice weekly, through the year.
(All special students in Physics are expected to attend this course).

II. Special Course on Molecular Dynamics by Sir Wm. Thomson.

Sir William Thomson, D. C. L., F. R. S. L. & E., etc., Professor of Physics in the University of Glasgow, will deliver in October next, a course of eighteen lectures on *Molecular Dynamics*.

An introductory lecture will be given on Wednesday, October 1. The other lectures will follow on consecutive days.

Professors and students of physics from other institutions are invited to attend and arrangements will be made by which they may easily obtain temporary lodgings, provided an early intimation is received of their intention to come. A registration fee of $5 will be required from such persons as follow the course, unless they are in other ways connected with this university.

III. Annual Course of Instruction for Undergraduates in General Physics.

This course will embrace experimental lectures, recitations, and examinations, five times a week throughout the year, with one half-day each week given to laboratory work. The subjects taken up will include Mechanics, Acoustics, Optics, Light, Heat, Electricity, and Magnetism.

This course should precede the study of Chemistry and Biology. A knowledge of Plane Trigonometry is essential for admission to it.

IV. Laboratory Work.

The Physical Laboratory is furnished with apparatus purchased from the best European and American makers, selected with special reference to investigations, and especially valuable for researches in electricity, magnetism, light, and heat. The laboratory will be open for work, daily through the year.

Note.—Candidates for the degree of Ph. D., who take Physics as a principal subject will be expected to attend Professor Rowland's lectures for at least two years; to work not less than two years in the laboratory or to show such attainments in the mathematical theories of Physics as may be regarded as an equivalent; to exhibit a familiarity with a selected group of subjects, such as are treated by the following authors:

History: Poggendorff, Grant (History of Physical Astronomy);
Mechanics: Kirchhoff, Thomson & Tait, Poisson, Duhamel, Jacobi, Peirce, Resal, Routh, Newton, and (on special topics) Riemann, Beer, and Lamé;
Sound: Rayleigh, Helmholtz;
Optics: Fresnel (special memoirs), Billet, Verdet, Gauss (Dioptrische Untersuchungen), Young, Helmholtz (Physiologische Optik);
Heat: Clausius, Rankine, Verdet, Rühlmann, Briot, Fourier;
Electricity and Magnetism: Maxwell (complete treatise), Faraday, Wiedemann, Mascart, De la Rive, Thomson (papers on Electricity and Magnetism).

Such candidates will also be required to present a thesis upon some subject in that branch of Physics upon which they have been especially engaged.

WORK OF THE PAST YEAR, 1883-84.

The rooms devoted to the Physical Laboratory have been open daily for the prosecution of advanced study and research, under the direction of Professor Rowland and Dr. Hastings.

During the year original investigations in the following subjects have been carried on:

On the photography of the spectrum by the concave grating.
On the variation of the magnetic permeability with change of temperature.
On the distribution of heat in the solar spectrum.
On the determination of the B.A unit of electrical resistance in absolute measure.
On the determination of the specific resistance of mercury.

Experiments have been carried on, under the direction of Professor Rowland, with an appropriation from the government of the United States, with the view to aid in establishing an international unit of electrical resistance.

Advanced students have also taken part in meetings weekly, for the reading and discussion of the current physical journals.

Lectures have been given by Professor Rowland on Thermodynamics, Heat Conduction, and Physical Optics, four times weekly through the year.

The work of a part of the students has been guided by Dr. Hastings. The major course has included lectures, weekly through the year, and daily work in the laboratory, especially on Wednesdays. The minor course in General Physics has included instruction daily through the year in Elementary Mechanics, Acoustics, Heat, Magnetism, Electricity, and Light, and a weekly exercise in the laboratory under Dr. Hastings and Mr. Reid.

CHEMISTRY

AND MINERALOGY.

PROGRAMME FOR 1884-5.

The courses in Chemistry are intended to meet the wants (1) of graduates who make Chemistry their specialty, or who select it as one of their subordinate subjects for the degree of Doctor of Philosophy; (2) of undergraduate students who study Chemistry for general training; (3) of special students who for good reasons have neither received a bachelor's degree nor matriculated at this University. The first and second years' courses are designed mainly for undergraduates, though graduates and special students who have not done an equivalent amount of work will be required to follow such portions of these courses as may seem desirable.

I. Advanced Work.

1. Laboratory Work.

Most of the work of advanced students is carried on in the laboratory, which will be open to them daily, except Saturday, from 9 a. m. until 5 p. m. The work, which will consist in making difficult and typical preparations and in carrying out investigations on assigned topics, will be wholly under the direction of Professor Remsen.

2. General Lectures. (By Professor Remsen).

Advanced topics will be treated in lectures which will be given two or three times a week during the first half-year. These will be supplementary to the courses in general chemistry given during the first two years. The special topics will be changed each year. This year the course will be supplementary to the lectures on the Chemistry of the Compounds of Carbon.

3. Historical Lectures.

During the second half-year there will be a course of about twenty lectures on historical topics selected and assigned by Professor Remsen to Fellows and other advanced workers in the chemical laboratory.

This work, while serving to familiarize students with chemical literature, is intended also to aid them in acquiring the art of presenting subjects in the form of lectures before audiences. All those who look forward to the career of teachers of chemistry will be required to take active part in the exercises.

4. Journal Meetings.

The instructors and advanced students will meet twice a week for the purpose of hearing reports on the articles contained in the current journals of chemistry.

The reports are furnished in turn by all who attend the meetings. All the principal chemical journals are read and reported upon.

II. First Year's Course.

This consists of laboratory work and lectures or recitations.

1st Half-Year: Introduction to General Chemistry.
Lectures and examinations daily except Saturday (by Professor Remsen).

Laboratory Work.
Three times weekly, laboratory open from 1 *to* 4 *p. m., Monday, Tuesday, and Thursday.* Work under the direction of Professor Remsen, Associate-Professor Morse, and Dr. Keiser.

2nd Half-Year: General Chemistry.
Conversational exercises supplementary to the course of the first half-year; *three times weekly* (by Associate-Professor Morse).

Laboratory Work.
As above, continued.

Mineralogy.
Introduction to Crystallography and Descriptive Mineralogy; *twice weekly* (by Dr. Williams).

III. Second Year's Course.

The second year's course is a continuation of that just described; together they form what is known as the Major Course.

1st Half-Year: Analytical Chemistry.
Lectures and examinations four times weekly (by Associate-Professor Morse).

Descriptive Mineralogy.
Once weekly (by Dr. Williams).

Laboratory Work.
Daily except Saturday, 2–5 *p. m.* (under the direction of Professor Remsen and Associate-Professor Morse).

2nd Half-Year: Chemistry of the Compounds of Carbon.
Lectures and examinations daily except Saturday, (by Professor Remsen).

Laboratory Work.
As above, continued.

IV. Applied Chemistry.

Opportunity will be offered for work in Applied Chemistry in almost any direction. Some instruction will be given in the assaying of ores. The object of this work is not to make assayers in the narrow sense of the word, nor mere analysts of certain products, but to afford the thoroughly trained chemist an opportunity to familiarize himself with some of the more important applications of his science.

V. Mineralogy and Geology.

In addition to the elementary instruction in Mineralogy included in the regular chemical courses as above described, Dr. George H. Williams will give a course in general Inorganic Geology extending through the first half-year; and special laboratory instruction in Mineralogy and Petrography throughout the year.

WORK OF THE PAST YEAR, 1883-84.

The Chemical Laboratory is a new building which covers an area of about 50 by 100 feet and has three full stories and a basement. In the basement are the necessary conveniences for assaying and other furnace operations. On the next floor there are large rooms devoted mainly to qualitative and quantitative analysis. On the second floor, are the rooms for research work, those of the director, the library, and a lecture room for General Chemistry. On the third floor, are rooms for the chemical and mineralogical collections, a working and lecture-room for mineralogy, and a second lecture-room for chemistry. The laboratory will conveniently accommodate about ninety working students.

Advanced students have been engaged daily in the laboratory in prosecuting such work as seemed best adapted to the purposes of each. Those who have completed the full courses in General Chemistry, including from two to three years' work in qualitative and quantitative analysis and about a year's work in making difficult and instructive preparations, were encouraged to undertake the solution of original problems.

The following investigations have been completed during the year. Others are in progress.

A contribution to the history of active oxygen.
The action of heat on ethylene.
On the chemical conduct of the sulphinide obtained by oxidizing *a*-naphthalene-sulphamide.
The effect of light on fermentation.
The relative stability of halogen derivatives of carbon compounds.

The results of these investigations have either been already published or will soon appear in the *American Chemical Journal.* Some of them have been read before the Johns Hopkins Scientific Association at its regular meetings.

The Fellows and other advanced students have met the instructors twice a week during the year for the purpose of keeping abreast of the current chemical literature. All the important journals have been carefully read, and full reports of the various articles have been made.

These students have been often called upon to treat important chemical questions in a broad way, going to the original sources and presenting the results in a complete form. In most cases the topics so investigated have been connected with the experimental work going on at the time; but other questions also have been elaborated in this way which bore less directly on the current studies. In several cases carefully written reports of the results obtained have been prepared. The excellent library of chemical books and journals which is accessible to the students in the laboratory, at all reasonable hours, has greatly facilitated the execution of this very desirable literary work.

At the beginning of the year subjects were assigned to the Fellows and others for the preparation of lectures on various chemical topics treated historically; and sixteen such lectures were the result. These were prepared from a careful study of the original articles in the journals, and were not borrowed from books on the history of chemistry. Full abstracts of these lectures, furnished with complete references to the articles consulted, are to be prepared and preserved in the chemical library. The lectures given were as follows:

Two by Mr. D. T. Day on "The History of the Halogens";
Two by Mr. H. N. Stokes on "The History of Oxygen";
Two by Mr. E. H. Keiser on "The Chemistry of Iron Historically Considered";
Two by Dr. J. R. Duggan on "The History of the Azo- and Diazo-Compounds";
One by Dr. G. H. Williams on "The Relation between Crystalline Form and Chemical Constitution";
One by Mr. A. G. Palmer on "The History of Benzene";
One by Mr. H. W. Hillyer on "Stas's Work on Atomic Weights";
One by Mr. J. E. Talmage on "The History of the Alkali Metals";
Two by Dr. Morse on "The History of Phosphorus";
Two by Professor Remsen on "The Basicity of Acids."

In addition, the work of the year has consisted of the courses below mentioned:

Laboratory Work for undergraduates through the entire year, conducted by Professor Remsen and Dr. Morse.

Lectures by Professor Remsen:
General Chemistry (Non-Metals), *five times weekly, first half-year.*
Chemistry of the Compounds of Carbon, *five times weekly, second half-year.*

Courses by Dr. Morse:
Analytical Chemistry, *four times weekly, first half-year.*
General Chemistry (Non-Metals), *five times weekly, second half-year.*

Courses by Dr. Williams:
Practical exercises in Mineralogy and Petrography, through the entire year.
Mineralogy, *three times weekly, first half-year.*
Geology, *three times weekly, second half-year.*

Six numbers of the AMERICAN CHEMICAL JOURNAL have appeared within the year. These are Nos. 3, 4, 5, 6 of Vol. V, and Nos. 1 and 2 of Vol. VI.

BIOLOGY.

PROGRAMME FOR 1884-85.

I. Collegiate Instruction.

This is designed especially for undergraduate students, but graduate students who have not had a thorough preliminary training will be required to follow the instruction in those subjects of the college course in which they are found to be deficient, before they will be permitted to undertake advanced biological studies or engage in original research.

First Year (Minor) Course.

This has been planned to meet the needs (1) of those who intend ultimately to take up some one branch of Biology (Zoölogy, Physiology, or Botany) for special study; (2) of students, graduate or undergraduate, who expect later to study medicine, but meanwhile desire, as a valuable preparation, to obtain some general knowledge of the phenomena, laws, and conditions of life; (3) of those who desire, as a part of their general college training, some acquaintance with the methods of modern experimental and observational science, and select Biology as a subject of study with that end in view.

The course consists of five lectures or recitations weekly throughout the academic year, with laboratory work. The laboratory work takes the place of the greater part of the outside reading required in connection with most other undergraduate courses in the university. The following subjects form together the year's work.

1. General Biology.

Three lectures or recitations weekly from the commencement of the session until the middle of April.

Attention is directed to the broad characteristic phenomena of life and living things rather than to the minutiæ of descriptive Botany or Zoölogy, or the character of orders, genera, and species. In the laboratory the student learns how to observe, how to verify and describe what he observes, how to dissect, and how to use a microscope; he examines selected vegetable and animal types from unicellular organisms, as the yeast-plant and Amœba, to the fern and the flowering-plant on one side and the crayfish and a mammal on the other. In the lecture room attention is mainly given to the fundamental biological facts and laws which the particular plant or animal under consideration is fitted to illustrate, the object being rather to give the student an idea of what is meant by the terms living thing, plant, animal, tissue differentiation, life history, organ, function, etc., than to teach him the elements of Botany and Comparative Anatomy as commonly understood. The organisms studied are Torula, Protococcus, Amœba, Bacteria, Penicillium, Mucor, Spirogyra, Nitella, a moss, a fern, a flowering-plant, Infusoria, Hydra, starfish, earthworm, crayfish, clam, squid, cartilaginous fish, frog, terrapin, pigeon, and rat; so that at the close of the course the student has a practical knowledge of a typical example from each of the main divisions of plants and animals, on which to base further reading.

2. The Embryology of the Chick.

Three lectures or recitations weekly from the middle of April until the close of the session.

In this course the student, who has already in his General Biology observed the natural arrangement of animals and plants in diverging series ranging from a simple bit of living matter to highly complicated organisms, studies the individual development of one of the higher animals, from its start as an almost formless bit of living matter to its final highly complex structure. The increasing differentiation of tissues and organs which he has noted as higher and higher plants and animals were dissected, he now sees exemplified by the chick embryo in different stages of development. At the same time a good foundation is laid for subsequent advanced study in Vertebrate Morphology.

3. Osteology, Human and Comparative.

Two lectures or recitations weekly until the middle of April, with practical study on selected skeletons.

The student begins with the human skeleton, which, as the most minutely and accurately described of all conveniently accessible animal structures, is well fitted to train him to observe closely and accurately. He then studies a skeleton from each of the chief orders of the Mammalia and two or three from each of the remaining main groups of Vertebrata.

4. Plant Analysis.

Practical instruction twice weekly from the middle of April until the close of the session.

The student is taught how to collect and preserve plants; and by the analysis of a number of flowering plants under the direction of his teacher, gets a good introduction to the terminology of descriptive botany, and learns how to use a botanical key for the recognition of species.

Second Year (Major) Course.

This is designed for those who, having completed the above minor course, desire to proceed farther with biological studies. Ultimately the second year's work in biology will be, at the choice of the student, one of three courses; in the first of these Animal Physiology will be the dominant study; in the second, Animal Morphology; in the third, Botany; for the present a choice is only offered between the first and second of the three.

[To complete his major course a student must, after finishing his minor, take either 1, 2, and 3, of the subjects below named, or 2, 3, and 4. The former combination is especially fitted for those who intend afterwards to study medicine].

1. Mammalian Anatomy.

Twice weekly, until Christmas.

In connection with this course the student dissects one of the higher mammals with all the minuteness with which the human body is dissected in a medical school. He thus not merely learns how to dissect thoroughly, but acquires a knowledge of the names, general distribution and structure of nearly all the muscles, nerves, vessels, and viscera, and becomes fitted to take up profitably the professional study of the details of descriptive and regional Human Anatomy, and so saves much time when he afterwards enters a medical school.

2. Animal Physiology and Histology.

Three lectures or recitations weekly during the year.

This course is designed to give the student a good knowledge of the healthy properties and mode of working of the various tissues and organs of the higher animals, man included; also to give

him a good knowledge of their microscopic structure. In the laboratory each student examines for himself the histology of each organ and tissue, and thus learns the use of reagents and embedding materials, the methods of mounting specimens, etc.; he also studies practically the composition of the more important organs and tissues, the chemistry of digestion, the fundamental properties of living muscles and nerves, the beat of the heart, the phenomena of reflex action, etc. Important physiological facts, which require special skill for their exhibition or the employment of especially delicate instruments, are demonstrated to the class. There will be, as a rule, one such demonstration weekly.

3. Elements of Zoölogy.

Two lectures or recitations weekly from Christmas until the end of the academic year.

A systematic course of lectures on the structure, relationships, and classification of animals. In the laboratory the student will dissect a number of forms selected to supplement the types studied in the General Biology course.

4. Marine Laboratory.

At least two months' study at the marine laboratory of the University between June 1st and August 31st.

This may be taken in one year or a month may be taken in each of two consecutive years.

II. University Instruction and Opportunities.

This is designed for graduates who have already such a knowledge of Biology as might be obtained by following the collegiate major course in that subject, and for others who, although not graduates, satisfy the university authorities that they are competent to undertake advanced work. In the university courses but little of the teaching is given by formal lectures; the instructors come into close daily contact with the students, supervise their work, direct their researches, and advise as to their reading.

1. Animal Physiology.

The new biological laboratory opened last October, has been especially constructed with reference to providing opportunity for advanced work in experimental physiology. The collection of physiological instruments belonging to the University is unusually large and complete and is yearly added to,—the Trustees providing an annual sum for the purchase of instruments wanted for any particular investigation, or which for other reasons it is desirable to have in the laboratory. There is also a well-fitted-up workshop in the laboratory in which a skilled mechanic is kept constantly at work repairing and constructing instruments. The laboratory contains two large rooms for general advanced work in animal physiology, in addition to others specially designed for work with the spectroscope, with the myograph, for electro-physiological researches, and for physiological chemistry.

2. Animal Histology.

The laboratory contains a special room constructed for advanced histological work, and well supplied with apparatus and reagents. There is also a room for micro-photography.

3. Animal Morphology.

Rooms for advanced work in this subject are also contained in the laboratory and a course of advanced lectures will be given by Dr. Brooks. The chief advanced study in animal morphology is however carried on at the Marine Laboratory, open at the seaside from the beginning of June until the end of August, under the direction of Dr. Brooks. The Marine Laboratory possesses a steam launch, and is supplied with the necessary dredges, boats, aquaria, microscopes, etc.

4. Physiological Psychology.

During the academic year a course of lectures, combined with laboratory work, will be given by Dr. G. Stanley Hall, in connection with the psychological courses of instruction in the university.

5. Lectures.

Short advanced courses of lectures are given from time to time on selected physiological and morphological subjects.

6. Journal Club.

A Journal Club, composed of the instructors and advanced students, meets weekly for the reading and discussion of recent biological publications.

7. Library Facilities.

The laboratory contains a library supplied with standard biological works and complete sets of the more important journals. There is also a special collection of books which have been brought together in connection with researches carried on in the laboratory. An effort is always made to procure for anyone engaged in a particular investigation all publications bearing on his work but not easily accessible, as graduation theses, occasional publications from laboratories in Europe and elsewhere, etc. The biological library receives regularly about forty biological periodicals, including all the important physiological and morphological journals in English, French, German, and Italian.

The general library of the University receives all the chief journals of general science, and the transactions of all the leading learned societies of the world.

The Library of the Peabody Institute, within five minutes' walk of the University, contains complete sets of many of the chief biological journals, of the proceedings of learned societies, and other works of reference.

In the library of the Medical and Chirurgical Faculty of Maryland, a very large number of medical periodicals is accessible to members of the University.

The proximity of Washington is of special value to advanced students of physiology. The Library of the Army Medical Museum in that city contains an almost unrivalled store of physiological works which are available under conditions favorable to study.

8. Publication.

In connection with the biological laboratory there is published a journal (*"Studies from the Biological Laboratory"*) which contains the results of most of the researches carried out in the laboratory; a ready means of publication for original work is thus secured. The *University Circulars*, which appear at brief intervals throughout the year, are available for preliminary statements, securing priority for discoveries while more detailed accounts are in course of publication.

III. Naturalists' Field Club.

This was organized by members of the University, but includes in its list of members other residents of Baltimore interested in Natural History. The club works in three sections—Geology and Mineralogy, Zoölogy, Botany. Each section elects its own officers and arranges for its own field excursions and its own meetings. There are also monthly meetings of the whole club, when the chairmen of the different sections report progress and an address on some topic of Natural History is given by one of the members.

The mineralogical collections of the club are preserved in the Chemical Laboratory; the botanical and zoölogical in the Museum of the Biological Laboratory.

WORK OF THE PAST YEAR, 1883-84.

I. Laboratory Work.

The Biological Laboratory has been open for eight hours daily during the year, for the prosecution of advanced study and research and for courses of practical instruction in connection with classes.

During the year original investigations, the results of which either have been or soon will be published, have been made in the following subjects:

The nature of the process of the coagulation of blood. The chemical composition of the blood of the Terrapin. The influence of various salts and other substances on the contraction of the arterioles. The suction-pump action of the heart. The influence of sudden variations of arterial pressure on the rhythm of the heart. The action of carbolic acid on the heart and its antagonism by atropin. The influence of convallarin and convallamarin on the heart. The anatomy of Nemertians. The development and metamorphosis of various insects. The development and histology of Salpa. The histology of Amiurus.

In connection with the regular class instruction, first year students thoroughly studied a number of typical fungi, green plants, and animals; the skeletons of about twenty selected vertebrates; and the development of the chick in the egg. In the spring there were a few practical lessons in the elements of Systematic and Descriptive Botany.

Second year students worked at the histology of the tissues and organs of the higher vertebrata (especially man); the physiological properties and functions of the tissues and organs; the physiology of digestion; the chemistry of bile, urine, etc. The stock of physiological apparatus belonging to the University being unusually large, and including several duplicates of all the more frequently used instruments, each student in the class of Animal Physiology had the opportunity and was required to perform for himself all the really fundamental physiological experiments, save such as required some special skill or the use of very delicate apparatus; these were demonstrated to the class. The cat was also thoroughly dissected by the second year students.

II. Advanced Instruction.

A course of twenty-three advanced lectures was given as follows:

Four lectures by Professor Martin on "The Causes of Chemical Degradation in the Animal Body."

Four lectures by Mr. W. H. Howell on "The Consumption of Matter by the Animal Body under various conditions."

Two lectures by Mr. F. S. Lee on "The Formation of Fat in the Animal Body."

Four lectures by Mr. L. T. Stevens on "The Relative Value of Various Foodstuffs."

One lecture by Mr. H. F. Nachtrieb on "The Physiology of Hunger and Thirst."

Three lectures by Mr. Otto Lugger on "The Metamorphosis of Insects."

Two lectures by Mr. H. L. Osborn on "The Embryology of Insects."

Three lectures by Mr. H. W. Conn on "The Relationship between Vertebrates and Invertebrates."

Dr. W. K. Brooks gave a course of about thirty-five lectures on the Morphology of the Crustacea.

Professor W. Trelease, of the University of Wisconsin, delivered in January fourteen lectures on "Vegetable Physiology." He also delivered in Hopkins Hall four lectures on "The Fertilization of Flowers."

Most of the advanced work, however, was carried on individually, and not in class; each worker taking up some special topic for study under the immediate direction of some one of the instructors. In addition to the original researches already enumerated, certain graduate students have in this manner carried on advanced study in various directions.

Students engaged in this kind of study (which forms a stepping-stone between class-work and original research), are usually given some important original article, and shown how to repeat and verify for themselves (and criticise, if necessary) the experiments and results described in it. By studying and repeating the original work of others they learn the methods of biological investigation, and are thus trained to plan and carry out researches themselves. In connection with this work, students are also taught how to hunt up and utilize the bibliography of a subject.

III. Class Instruction.

Courses of lectures for undergraduates were given as follows:

Osteology, *twice weekly, through the year.*
Mammalian Anatomy, *twice weekly, until Christmas.*
Animal Physiology and Histology, *three times weekly, through the year.*
General Biology, *three times weekly, until the middle of April.*
Embryology of the Chick, *three times weekly, from the middle of April until the close of the session.*
Plant Analysis, *twice weekly, in May.*

IV. Marine Laboratory.

During the summer of 1883, the seaside Zoölogical Laboratory for the study of forms of marine life, was open at Hampton, Va., from May 1 until September 29.

The advanced work included original investigations on the following subjects:

The anatomy and development of barnacles, the anatomy and development of crabs, the histology of Eudendrium, the anatomy and development of Balanoglossus, the development of the oyster, the anatomy of Lingula, the protozoea stage of crabs, the development of Annelids, the anatomy and development of Chrysaora, the origin of the eggs of hybrids and tunicates, the function of the semi-circular canals of sharks, and the general zoölogy of the Hydro-Medusae.

V. Publications.

Number 1 of the third volume of "*Studies from the Biological Laboratory*" was published in March. It contains:

I. Significance of the larval skin of Decapods. By H. W. Conn. With two plates.
II. Life history of Thalassema. (Abstract.) By H. W. Conn. With one plate.
III. Of the Gill in some forms of prosobranchiate Mollusca. By H. L. Osborn. With three plates.

Number 2 of Volume III is in press.

Articles by various members of the biological department have also been published in the *University Circulars*, in the *Journal of Physiology*, and in the *Zoölogischer Anzeiger*. Abstracts of two researches have been printed in the Proceedings of the Royal Society of London, and will shortly appear in full in the "Philosophical Transactions."

The report of the Oyster Commission of the State of Maryland, prepared by Dr. W. K Brooks, Chairman of the Commission, and embodying the results of his prolonged investigations at the Marine Laboratory upon the propagation of the American Oyster, was issued in February.

ANCIENT AND MODERN LANGUAGES.

PROGRAMMES FOR 1884-85.

GREEK.

I. Greek Seminary.

PROFESSOR GILDERSLEEVE will conduct the Greek Seminary, the plan of which is based on the continuous study of some leading author or some special department of literature.

The Seminary consists of the Director, Fellows, and Scholars, and such advanced students, to the number of six, as shall satisfy the Director of their fitness for an active participation in the work, by an essay, a critical exercise, or some similar test of attainments and capacity. All graduate students, however, may have the privilege of attending the course.

During the next academic year the study of *The Attic Orators* will constitute the chief occupation of the members. There will be two meetings a week during the entire session. Especial attention will be paid to the development of language and style and to the antique canons of aesthetic criticism. The rhetorical works of Dionysios of Halikarnassos will be studied in connexion with this course.

The student should possess the text of the orators (Teubner ed.). Blass's *Geschichte der Attischen Beredsamkeit* is an indispensable auxiliary. An effort will be made to have the seminary library fairly complete in the important works of reference for the study.

II. Advanced and Graduate Courses.

1. PROFESSOR GILDERSLEEVE will also conduct a course of *Practical Exercises in Greek*, consisting chiefly in translation at dictation from Greek into English and English into Greek, two meetings a week, from the beginning of the session to the first of January. Advanced undergraduates will be admitted to this course upon the recommendation of their advisers.

2. Professor Gildersleeve will lecture on the *Syntax of the Moods and Tenses* once a week until January 1, and thereafter twice a week until April 1.

3. Professor Gildersleeve will lecture on the *Greek Lyric Poets*, with illustrative readings, once a week after January 1.

4. DR. BLOOMFIELD will give a course in the Comparative Grammar of Greek, during the first half-year.

5. Notices as to other courses are reserved.

III. New Testament Greek.

MR. J. RENDEL HARRIS will give the following courses:

1. Paleography, with especial reference to the Documents of the New Testament.
2. The Gospel of Mark, with an examination of the question as to the authenticity of the last twelve verses.
3. Portions of the Sub-Apostolic literature will be read and criticized, and in particular the second epistle of Clement and the "Teachings of the Twelve Apostles."
4. A short course will probably be given on some questions connected with Church History and the growth of Christian Institutions.

IV. Undergraduate Courses.

1. Isocrates, I, IV; Xenophon, *Hiero.*
   Three times weekly, first half-year. DR. SPIEKER.
   Conferences on Greek History.
   Weekly, first half-year. PROFESSOR C. D. MORRIS.
2. Homer, *Iliad*, XVI, XVII; Euripides, *Hercules Furens.*
   Four times weekly, second half-year. DR. SPIEKER.
3. Plato, *Gorgias.*
   Four times weekly, first half-year. PROFESSOR C. D. MORRIS.
4. Aeschylus, *Septem c. Thebas;* Euripides, *Iphig. in Taur.*
   Three times weekly, second half-year. PROFESSOR C. D. MORRIS.
   Conferences on Greek Grammar.
   Weekly, second half-year. PROFESSOR GILDERSLEEVE.
5. Prose Composition.
   Weekly exercises in connection with each of the above courses.

Private Reading. Students having the time are encouraged to pursue parallel courses of private reading under the direction of the instructor. Those who pass examinations on such work will be able to complete their courses in shorter time than otherwise. Examinations on the following books will be provided for 1884-5:

1*a*. Merry's *Selections from Herodotus.*
2*a*. Plutarch, *Themistocles, Cicero.*
3*a*. Homer, *Odyssey.* XXI–XXIV.
4*a*. Xenophon, *Oeconomicus.*

NOTE.—The work provided for subsequent years will be arranged on a similar scheme, although the books offered will be different. Examinations on the courses in Private Reading will be held at the end of each half-year. Class courses 1 and 2 are to be taken as the first year's work, with 1*a* and 2*a* of Private Reading. The second year's work will consist of 3 and 4, with 3*a* and 4*a* of Private Reading. Should any student be unable to do the Private Reading in connection with his class work, he may take the examination on Private Readings or extra courses of class work in a subsequent year. One course of class work is in all cases considered the equivalent of two courses of parallel reading.

DR. A. EMERSON will conduct courses in Classical Archæology through the year, for graduate as well as undergraduate students.

LATIN.

I. Latin Seminary.

DR. WARREN will conduct the Latin Seminary. The study of *Roman Satire* will form the chief occupation of the members during the next academic year. There will be two meetings a week throughout the year one of which will be devoted to critical interpretation and the other to auxiliary studies, and to the discussion of papers presented by members of the Seminary. It is probable that during the first half of the year more particular attention will be paid to Horace and Lucilius, and in the latter half to Juvenal, and in a less degree to Persius.

Students are advised to provide themselves in advance with Keller and Holder's Editio Minor of Horace (Leipzig, 1878) and Schütz's edition of Horace's Satires (Berlin, 1881); Otto Jahn's edition of Juvenal with the Scholia, (Berlin, 1851), or Mayor's Thirteen Satires of Juvenal with a commentary (2 vol., Macmillan, 1878 and 1880); and with Lachmann's edition of Lucilius (Berlin, 1876 with the Index Lucilianus of Harder, Berlin, 1878), or the edition of Lucian Mueller (Leipzig, 1872).

A good reading knowledge of German is very essential for the successful prosecution of the course.

II. Advanced and Graduate Courses.

1. In the first half-year DR. WARREN will give a course of sixteen lectures on the Roman Satirists.

2. In the latter half of the year DR. WARREN will conduct a course of Practical Exercises in Latin, one meeting a week, consisting mainly in translation at dictation from Latin into English, and English into Latin.

III. Undergraduate Courses.

1. Livy, two books.
   Three times weekly, first half-year. DR. SPIEKER.
   Conferences on Roman History.
   Weekly, first half-year. DR. SPIEKER.
2. Horace, *Select Odes, Satires and Epistles.*
   Four times weekly, second half-year. DR. SPIEKER.
3. Cicero, *de Oratore I, Tusculan Disputations I.*
   Three times weekly, first half-year. PROFESSOR C. D. MORRIS.
   Reading at sight.
   Once weekly.
4. Catullus; Martial, *Select Epigrams.*
   Seven times in two weeks, second half-year. PROFESSOR C. D. MORRIS.
   Reading at sight.
   Once in two weeks.
5. Plautus, *Mostellaria;* Terence, *Andria.*
   Three times weekly, first half-year. DR. WARREN.
   Reading at sight.
   Once weekly.
6. Tacitus, *Dialogus de Oratoribus, Germania, Annales I.*
   Seven times in two weeks, first half-year. DR. WARREN.
   Reading at sight.
   Once in two weeks.
7. Prose Composition.
   Weekly exercises in connection with each of the above courses.

Private Reading. Students having the time are encouraged to pursue parallel courses of private reading under the direction of the instructor. Those who pass examinations on such work will be able to complete their courses in shorter time than otherwise. Examinations on the following books will be provided for 1884–5:

1a. Cæsar, *Bellum Civile;* Cicero, *de Amicitia.*
2a. Horace, *Epodes and Carmen Sæculare;* Ovid, *Fasti,* I, II.
3a. Cicero, *Orator, Tusculan Disputations,* II.
4a. Pliny, *Select Letters.*
5a. Plautus, *Captivi;* Terence, *Phormio.*
6a. Tacitus, *Agricola, Histories* I; Suetonius, *Life of Tiberius.*

NOTE.—The work provided for subsequent years will be arranged on a similar scheme, although the books offered will be different. Examinations on the courses in Private Reading will be held at the end of each half-year. Class courses 1 and 2 are to be taken as the first year's work, with 1a and 2a of Private Reading. The second year's work will consist of courses 3 and 4, with 3a and 4a of Private Reading. (5 and 6, with 5a and 6a, are offered as alternatives.) Should any student be unable to do the Private Reading in connection with his class work, he may take the examination on Private Readings or extra courses of class work in a subsequent year. One course of class work is in all cases considered the equivalent of two courses of parallel reading.

SHEMITIC LANGUAGES.

Professor HAUPT will give the following courses:

1. Hebrew for beginners.
   Elements of the grammar and interpretation of the story of Joseph in the book of Genesis (ch. 37–45). Monday and Friday, 4 p. m.
   Gesenius' *Hebrew grammar*, translated by Edward C. Mitchell; *Hebrew and Chaldee Lexicon* to the Old Testament by B. Davies, revised by E. C. Mitchell, Andover, 1883; *Liber Genesis*, ed. S. Baer and Fr. Delitzsch. Lipsiae, 1869.
2. Hebrew Exercises.
   Reading historical books at sight. Thursday, 4 p. m.
3. Critical Interpretation of selected Psalms.
   Tuesday, 4 p. m.
   Liber Psalmorum Hebraicus, ed. S. Baer and Fr. Delitzsch, Lipsiae, 1861.
4. Chaldean Grammar and Interpretation of the book of Daniel.
   Wednesday, 4 p. m.
   Luzzato's Grammar translated by J. S. Goldammer (New York, 1876); *Libri Danielis Esrae et Nehemiae*, ed. S. Baer and Fr. Delitzsch, Lipsiae, 1882.
5. Ethiopic: Interpretation of the book of Baruch.
   Dillmann's *Chrestomathia Aethiopica* (Lipsiae, 1866). Wednesday, 3 p. m.
6. Arabic: Reading of the Travels of Sindbad. (From the Arabian Nights).
   Beyrut Arabic Chrestomathy, Vol. I. Tuesday, 3 p. m.
7. Outlines of Assyrian Grammar.
   Thursday, 11 a. m.
8. Sardanapalus' Arabian Campaign (V R., 7, 82).
   Thursday, 12 m.
   Sir Henry Rawlinson's *Cuneiform Inscriptions of Western Asia*, Vol. V, Part I, London, 1880.
9. Interpretations of selected Sumero-Akkadian Hymns and Psalms.
   Thursday, 3 p. m.
   Haupt's *Keilschrifttexte*, Parts I–IV, Leipzig, 1881–82.

In reply to inquiries concerning the programme for 1885–86 it may be added (so far as announcement can be made at present), that there will be in *Hebrew*, besides exercises in reading at sight, Isaiah, and in *Chaldee* Ezra and Nehemiah; in *Arabic*, Qor'ân; in *Ethiopic*, the Homilies in Dillmann's Chrestomathy; and in *Assyriology*, introduction to the study of Babylonian texts, Nebuchadnezzar Inscriptions, Cyrus Cylinder; Nimrod Epic with the cuneiform account of the Deluge; Akkadian Exorcisms and Incantations. A *Syriac* course for beginners also will be given.

SANSKRIT AND THE COMPARATIVE GRAMMAR OF THE COGNATE LANGUAGES.

DR. BLOOMFIELD will give the following courses:

1. Beginner's Class in Sanskrit.
   Whitney's *Grammar*. Lanman's *Reader*. *Twice a week.*
2. Advanced Class in Sanskrit.
   Hitopadeça and *Kathâsaritsâgara* during the first half-year; *Çakuntala* during the second half-year.
3. Introduction into the Rig-Veda.
   Lectures and select hymns.
4. Advanced Vedic Class.
   Atharva-Veda during the first half-year, selections from the Brâhmaṇa and Sûtra literature during the second half-year.
5. Introduction into Comparative Philology.
   Lectures and Whitney's *Language and the Study of Language.*
6. Select chapters of Comparative Grammar of Greek.
   Based on Gustav Meyer's *Griechische Grammatik* and designed especially for the members of the Greek seminary. *During the first half-year.*

GERMAN.

Knowledge of German is required in all courses of study which lead to graduation. Instruction is provided to meet the requirements of different classes of students, as follows:

Class for Beginners.

This class will meet three times weekly through the year. The text-books used will be Whitney's Grammar, and Reader (first twenty-four pages), and Ahn-Henn's Rudiments (first half), with short selections in prose. The course does not count as part of the requirements for graduation, but is simply an aid provided by the University for those who are not ready to enter class A. Attendance upon this class is restricted to undergraduate students.

Note 1.—Candidates for Class A may offer as an equivalent for the work of the beginner's class:

Grammar: Declension, gender, conjugation, and the simpler rules of syntax.

Reading: Whitney's reader, the first 24 pages, or Adler's reader, the prose pieces in the first and second sections, or equivalents. They must also be able to render at sight simple English sentences into German.

Class A.

This is commonly called the minor course. For admission to it, the student, whether collegiate or graduate, must possess the knowledge indicated above.

All undergraduates, except the classical students, are required to follow this course or to show that they have an equivalent knowledge of German. Classical students are also advised to pursue this study and will receive from the instructor such counsel as will aid them in doing so, and his certificate will be needed before they can fully satisfy the requirements for graduation.

There will be five class meetings, weekly, through the year.

Classics: Prose; Drama.
Twice weekly.

Miscellaneous Selections.
Weekly.

Prose Composition, with Whitney's Grammar.
Weekly.

Oral practice in German; based upon familiar readings and exercises.
Weekly.

Note 2.—Candidates who offer German in place of Greek for matriculation will be examined on the work of Class A or its equivalent.

Class B.

Students who have completed the work of Class A or an equivalent may take a second year's course or any part of it.

There will be five meetings weekly, as follows:

Reading of German Classics (continued.)
Twice weekly.

Prose Composition.
Weekly.

Lectures on the History of German Literature from the Reformation, with Kluge's Geschichte der deutschen Literatur and readings.
Weekly.

Middle High German; selections from the Nibelungen Lied, Gudrun, etc.; lectures on the chief Teutonic epic cycles, with illustrations.
Weekly.

Exercises in German style and syntax.
Monthly.

Exercises in German conversation.
Enrollment for these exercises is optional.

Note 3.—Graduate students who show their fitness for it, may join certain classes in B while still in A.

(Statements as to advanced courses are reserved).

ROMANCE LANGUAGES.

Knowledge of French is required in all courses of study that lead to graduation. Instruction is provided to meet the needs of different classes of students, as follows:

Class for Beginners.

This class will meet daily through the year. The text-books used will be Breymann's French Grammar, Chardenal's First French Course, together with the beginning of Knapp's French Readings. The course does not count as part of the requirements for graduation but is simply an aid provided by the university for those who are not ready to enter class A, for which the work here done is considered a sufficient preparation.

I. French: Class A.

(Course for a first year).

To enter this course both a written and an oral examination must be passed. Candidates will be required to have a thorough knowledge of Grammar forms, especially of the irregular verbs, to have read one hundred duodecimo pages of French Prose and to have translated twenty-five pages of English exercises into French. For the oral examination they are requested to offer the texts they have used in preparation.

1. Reading of Literary French.
   Selections from Guizot, Dumas *père*, Th. Gautier, Daudet, Victor Hugo. Knapp: *French Readings. Twice weekly.*
2. Historical Course.
   Montesquieu: *Grandeur et Décadence des Romains. Weekly.*
3. Scientific Course.
   Milne-Edwards: *Précis d'Histoire Naturelle;* Flammarion: *Merveilles du Ciel. Weekly.*
4. French Composition.
   Syntax, *first half-year;* Idioms, *second half-year. Weekly.*
5. Lectures.
   The lectures will discuss Victor Hugo, and the Romantic school; Théophile Gautier and the Naturalists; Guizot and the Modern Historians. *Fortnightly.*

Opportunities for thorough training in French pronunciation and conversation will be given, a class meeting daily through the year.

II. French: Class B.

(Course for a second year).

Open only to those who have pursued the first year's course or its equivalent.

1. Lectures on French Philology, Phonetics, etc.
   Weekly.
2. Lectures on French Literature of the Middle Ages.
   Fortnightly, second half-year.
3. Middle French.
   Calvin, François de Sales, Montaigne, Satyre Ménippée, Brantôme, Rabelais, Des Périers, Marot, École de Ronsard, with lectures on sixteenth century Phonetics, Morphology and Syntax, accompanying the texts read. Darmesteter et Hatzfeld: *Morceaux Choisis. Twice weekly, first half-year.*

4. Old French.

Les plus anciens monuments, St. Alexis, Roland, Chrestien de Troyes, Renart, Rose, Villehardoin, Joinville, Froissart. Bartsch: *Chrestomathie de l'Ancien Français. Twice weekly, second half-year.*

5. Classical French.

Molière: *Le Misanthrope;* Corneille: *Le Cid;* Racine: *Phèdre. Weekly.*

6. Prose Composition.

Gasc's Prose Composition, *first half-year;* Original Essays, *second half-year. Weekly.*

III. Special Courses in Italian and Spanish.

1. Italian:

(*a*) *Literary Course.* Manzoni: *I Promessi Sposi;* Alfieri: *Abel;* Goldoni: *La Sposa Sagace, Gl' Innamorati;* Dante: *Inferno. Weekly.*

(*b*) *Historical Course.* Machiavelli: *Le Istorie Fiorentine;* Sonzogno's *Storia della letteratura italiana. Weekly.*

(*c*) *Grammar and Composition. Weekly.*

2. Spanish:

Selections from "Fernan Caballero," José Selgas, Lafuente, Javier de Burgos, Juan Valero, Emilio Castelar. Knapp: *Spanish Readings; first half-year.* Calderon: *La Devocion de la Cruz; El Mágico Prodigioso;* Cervantes: *Don Quijote; second half-year. Twice weekly.*

IV. Advanced Courses in Romance Philology.

(For advanced students, and candidates for the degree of Ph. D. taking this subject).

Course 1:

(*a*) Old French Seminary.

Critical examination of the earliest monuments of the language, viz.: *La Cantilène de Sainte Eulalie, Passion du Christ, Vie de Saint Alexis. Weekly.*

(*b*) Langue d'oïl Dialects.

Lectures and practical exercises. *Weekly.*

(*c*) Comparative Phonology of the Romance Languages.

Lectures. *Weekly.*

(*d*) Catalan and Modern Provençal (first half-year), Wallachian (second half-year).

Weekly.

(*e*) The History of Romance Studies in Europe.

Lectures. *Weekly.*

Course 2:

(*a*) Old French.

Aucassin et Nicolète (Suchier's edition). *Weekly.*

(*b*) Old Provençal.

XIII and XIV Century Extracts. Bartsch: *Chrestomathie Provençale. Weekly.*

(*c*) French Phonetics of the Major Course.

Weekly.

(*d*) Italian, with special students.

Thrice weekly.

(*e*) Spanish, with special students.

Twice weekly.

(*f*) Portuguese.

Braga: *Antologia portugueza;* Camões: *Os Lusiadas. Weekly.*

(*g*) Ladinian.

Ulrich: *Rhätoromanische Chrestomathie, (II Theil.). Weekly, second half-year.*

WORK OF THE PAST YEAR, 1883-84.

I. Greek.

Under the direction of Professor Gildersleeve the advanced students of Greek have been organized into a Greek Seminary. According to the plan of the seminary the work of each year is concentrated on some leading author or some special department of literature. During the past year the work has been in the Greek historians.

In the seminary proper, which met twice a week during the academic year, select portions of Thukydides were interpreted in turn by the different members of the seminary, with lectures and illustrative papers by the Director and the students.

Among the subjects treated may be mentioned: The composition of the different parts of the history of Thukydides, the principles that regulate the introduction of the Thukydidean speeches, use of the passive and middle in Thukydides, Thukydidean compounds, use of θέρος and χειμών in Thukydides, oracles in Herodotos, conditional sentences in Herodotos, the tract de Republica Atheniensium.

The work of the seminary was supplemented by the lectures of the Director on Greek Historiography, illustrated by readings and by an analysis of the treatises of Dionysios of Halikarnassos on the style of Thukydides.

Besides the seminary course proper, Professor Gildersleeve delivered twenty-five lectures on the Theory of the Cases, conducted twenty-two exercises in translating at dictation from Greek into English, and English into Greek, and gave a course of fifteen lectures on Lucian.

Mr. Harris conducted a class-course in New Testament Greek, twice weekly, through the year, and gave two courses, one, of six lectures, on some New Methods of Textual Cricitism, and the other, of three lectures on the newly published tract entitled "The Teachings of the Apostles."

Dr. Emerson conducted two classes in Pausanias and Greek Inscriptions, each meeting weekly during the second half-year, and a class in Greek Classical Antiquities, meeting twice weekly during the first half-year.

A public course on Classical Archæology, comprising fifteen lectures, was given during the year. The course began with a lecture by Dr. Charles Waldstein, four lectures were given by Mr. J. T. Clarke, three by Mr. W. J. Stillman, six by Dr. A. Emerson, and a closing lecture by Professor Gildersleeve.

Additional courses were conducted during the year, by:

Professor C. D. Morris, in

Thukydides, bk. VII, *four times weekly, first half-year.*

Sophokles, *Philoctetes;* Aristophanes, *Ranae, four times weekly, second half-year.*

(This class has also read at sight the Apology and Crito of Plato and about one-half of the Antigone of Sophokles).

Homer, *Iliad, once weekly, through the year.*

Dr. Spieker, in

Lysias, *four times weekly, first half-year.*

Homer, *Odyssey,* IX–XII; Euripides, *Alcestis, four times weekly, second half-year.*

Classes in Greek Prose Composition were also conducted by each of the instructors in connection with the courses above named.

Students have privately read for examination the following books:

Aeschylus, *Persae* (4).
Aristophanes, *Plutus* (1).
Demosthenes, *in Timocratem* (6).

Euripides, *Hippolytus* (4).
Herodotus, (Merry's Selections) (7).
Sophocles, *Electra* (1).
Xenophon, *Hellenica*, I, II, (7).

II. Latin.

The Latin Seminary under the direction of Dr. Warren, held two sessions a week throughout the year, the author selected for special study being Terence.

The plays of Terence were analyzed by the members of the seminary in turn, and a part of the Phormio and a very considerable portion of the Andria were made the subject of critical interpretation. Some twenty-five lectures were given by Dr. Warren on topics connected with the Roman drama, special attention being paid to the pre-Terentian literature, to the metres, and to the history of the text of Terence. Papers were presented embodying the results of special investigation by members of the seminary on the following subjects: on the Didascaliæ, on the peculiarities of G. Sulpicius Apollinaris as shown in the Periochae, on the position of adjectives and possessive pronouns relative to their substantives, on the critical value to be assigned to the citations of Terence found in Nonius Marcellus, on some striking differences between the metres of Plautus and Terence and those of Greek Comedy, on Terence's use of substantives as compared with that of Plautus, on the relative value of the different MSS. of Terence and their characteristic peculiarities, on Terence's use of the present participle, on the cases of ἀρχαϊσμός specially remarked upon by Donatus.

Dr. Warren also gave in the first half-year, a course of lectures on Latin Palæography, accompanied by practical exercises in reading fac-similes of manuscripts. In the latter half of the year, a similar course was given on Latin Epigraphy.

Additional courses have been conducted during the year, by:

Dr. Warren, in

Select Letters of Cicero and Pliny, Aulus Gellius, *three times weekly, first half-year.*
Juvenal, Select Satires, *three times weekly, second half-year.*
Horace, Select Satires, *once weekly, second half-year.*
Reading at Sight.

Professor C. D. Morris, in

Lucretius and Plautus, *seven hours in two weeks, first half-year.*
Tacitus, *four times weekly, second half-year.*
Reading at Sight.

Dr. Spieker, in

Livy, *four times weekly, first half-year.*
Horace, *three times weekly, second half-year.*

(Classes in Latin Prose Composition were also conducted by each of the instructors in connection with the courses above named).

Dr. Emerson, in

Classical Antiquities, *twice weekly, second half-year.*

Students have privately read for examination the following books.

Cicero, *de Senectute* (7); *de Amicitia* (7); *pro Roscio Amerino* (6); *de Finibus*, I, (4); *ad Atticum* (1); *de Natura Deorum*, I, (4); *Philippica*, II, (1).
Horace, *Epodes*, *Carmen Sæculare*, (6).
Livy, XXII, XXIII, (1).
Lucretius, V, (1).
Martial, (1).
Ovid, *Fasti*, I, II, (6).
Seneca, *de Tranquillitate Animi*, *Apocolocyntosis*, (1).
Suetonius, *Tiberius*, (2).
Tacitus, *Dialogus*, *Annals* III, (2).
Terence, *Andria*, (4).
Vergil, *Aeneid*, V, VI, (1).

III. Shemitic Languages.

The centre of Professor Haupt's work was the Old Testament. Hebrew was read two hours weekly, and was constantly referred to in all the other lectures on Arabic, Ethiopic, Assyrian, Sumero-Akkadian, and in the Assyriological exercises. With the exception of the last, all the courses were intended for beginners. Accordingly the instruction was given not in lectures but after the seminary method.

In *Hebrew*, the elementary difficulties having been overcome, portions of the Pentateuch were read and afterwards, at sight, some chapters from the books of Judges, Ruth, and Kings. The interpretation was confined chiefly to a thorough philological analysis. As a number of students who had studied Hebrew for several years took part in this elementary course, exegetical and critical problems were incidentally discussed, but attention was devoted mainly to a thorough training in the forms of the language. The grammar used was Dr. Mitchell's translation of Gesenius-Kautzsch.

The *Arabic* class, for want of a suitable text book in English, had to use Petermann's *Brevis linguae Arabicae grammatica*. After a preparatory training in the sounds and forms, the first chapters of Genesis (Saadia's Arabic version) were read and then the opening sura of the Qor'ân and an easy historical text without vowels. In the grammatical analysis the forms and the most important syntactical phenomena were thoroughly explained with a constant reference to the points of contact as well as of difference with the Hebrew language. In order to make the students acquainted with the use of the national Arabic lexica, Arabic definitions, chiefly from the Qamûs, were given and these served at the same time as exercises in reading at sight unpointed sentences. There were also composed by the students written exercises, conjugations of the more difficult irregular verbs and translations of syntactically interesting sentences from English into Arabic.

In *Ethiopic*, after some introductory lectures on the history of Abyssinia and the position of the Geez language in the cycle of the cognate idioms, the outlines of the grammar were given, and afterwards the reading and analysis of the *Narratiunculae de viris sanctis* in Dillmann's *Chrestomathia Aethiopica* were entered upon. The legends of St. Mark, Melchizedek, Abbâ Salâmâ, and Yared were read, and the beginning of the story of Macarius. In the grammatical interpretation the gutturals were especially treated of, with occasional references to Amharic and Tigriña and the close connection of the Geez language with Assyro-Babylonian was pointed out.

In *Assyrian* as well as in Ethiopic the lack of a convenient text book necessitated the dictating of the grammar. Thereupon the cuneiform Annals of Sardanapalus in Vol. V of Sir Henry Rawlinson's *Western Asia Inscriptions* were read: the account of the first five campaigns, the two against Egypt, the third against Baal of Tyre, the fourth against Achsheri (cf. Ahishahar 1 Chron. 7, 10) of Van, the fifth against Elam, and the beginning of the sixth against Shamash-shum-ukîn. Some written exercises with cuneiform paradigms of the Assyrian verbal inflexion, &c., were also composed.

In *Sumero-Akkadian* the great three-columned Syllabary in Haupt's *Keilschrifttexte* (Leipzig, 1881) was explained. The principal phenomena of the phonology of the pre-Shemitic idiom were discussed, the origin of some Akkadian ideographs from the archaic Mesopotamian picture writing traced and Akkadian words which have passed into Shemitic idioms especially into the language of the Old Testament were pointed out.

In the *Assyriological Exercises* for more advanced cuneiformists the sixth tablet of the Babylonian Nimrod Epic in Haupt's new edition (Leipzig, 1884) was read, and before this, select bilingual exorcisms, incantations, prayers, hymns and penitential psalms in parts II and III of Haupt's *Akkadian and Sumerian Texts* (Leipzig, 1881) and in Vol. IV of Sir Henry Rawlinson's *Cuneiform Inscriptions*, with special reference to Akkadian syntax and to the dialectical variations in the ancient Protochaldean idioms.

All the courses were two hours weekly, except Arabic and Ethiopic for each of which only a single hour weekly could be spared.

The proceedings of the *Shemitic Society* are given by the Recording Secretary, Dr. Arthur L. Frothingham Jr., in the April number of these *Circulars*.

IV. Sanskrit, etc.

Five courses in Sanskrit and a course in Comparative Philology were conducted by Dr. Bloomfield:

1. A beginner's class in Sanskrit, throughout the year. The most essential elements of the grammar were acquired in as short a time as possible, and then the student was brought face to face with the language, learning its structure and laws, not in the abstract, but in its living body. Five books of the *Nala* were read and thoroughly analyzed. The aim was either to prepare for the more advanced study of Indian philology in this university, or for private study, which is too difficult without such an introduction.

2. The advanced class in Sanskrit read during the greater part of the year the drama *Çakuntala*. The main effort was directed towards the Prākrit, which was constantly analyzed and compared with the Sanskrit. Toward the end of the year the class read selections from the Brāmaṇa literature.

3. Introduction into the Rig-Veda, throughout the year. After a short course of lectures, select hymns of this Veda were read. The language was studied from the point of view of the classical language; constant reference was made to the critical helps such as the *padapāṭha*, *anukramaṇī* and the metres.

4. During the first half of the session the Kauçika-sutra was read from the manuscripts and with the aid of a MS. commentary.

5. A practical exercise in Sanskrit Prose writing was conducted from Christmas to the end of the year, on the basis of Bühler's *Elementarcursus des Sanskrit.*

6. A course in the general principles of Comparative Philology was carried on throughout the year. It was introduced by ten lectures on the leading questions of Indo-European comparative grammar, (phonetic law and analogy, bi-syllabic roots, agglutination, etc.). For the rest of the year Prof. Whitney's "Language and the Study of Language" was made the basis of instruction, but this was constantly supplemented by lectures, which aimed to carry the subjects treated in the book up to the present day.

V. German.

Advanced courses were conducted as follows:

Gothic. *Weekly, first half-year.* DR. DIPPOLD.
Middle High German. *Twice weekly.* DR. DIPPOLD.
Deutsche Stilübungen and Essays. *Monthly.* MR. RADDATZ.
History of German Literature, consisting of lectures in German. *On alternate Saturdays.* DR. DIPPOLD.
Lectures on The Beast Epic and Middle Low German were also given, weekly, during the first half-year, by DR. GERBER.

The undergraduate classes were conducted by Dr. Dippold, with Mr. Raddatz in charge of the classes in Prose Composition.

In the first year's course Goethe's Egmont, Schiller's Maria Stuart, and Selections from Erler's Deutsche Geschichte, and from Scientific Prose were read. The first section read further Lessing's Minna von Barnhelm; and the second, Schiller's Wallenstein.

In the second year's course Goethe's Hermann and Dorothea, Faust, selections from Wilhelm Meister, and Lessing's Nathan were read; with the addition of sight readings from Emilia Galotti.

There were weekly exercises in Prose Composition in both the first and second year's courses.

Dr. Lehmann conducted twice weekly a class in German Conversation, for undergraduates and advanced students, and the major course students met each month, during the second half-year, under the direction of Dr. Dippold, for the reading and discussion of essays on works read in the course.

VI. Anglo-Saxon and English.

Advanced courses were conducted by Dr. Wood in:

Anglo-Saxon: Béowulf; Cædmon's Genesis. *Twice weekly.*
Old Saxon: Hêliand. *Weekly, first half-year.*
The advanced students also met fortnightly, under the direction of Dr. Wood, for work in general English philology, reports and discussions. Three of the papers prepared during the year for these meetings, were subsequently read before the University Philological Association.

Additional classes, including the first and second year's courses for undergraduates, were conducted as follows:

Anglo-Saxon: Sweet's Reader; Cynewulf's Elene. *Twice weekly.* DR. WOOD.
Early English (1300-1400). *Twice weekly.* DR. WOOD.
Chaucer. *Weekly.* DR. WOOD.
Shakspeare: Hamlet. *Twice weekly, first half-year.* DR. BROWNE.
English Prose Writers. *Twice weekly, second half-year.* DR. BROWNE.
Elements of English Phonetics. *Weekly, first half-year.* DR. WOOD.
Grammatical and Rhetorical Exercises. *Weekly.* DR. WOOD.
History of the English Language. *Weekly, second half-year.* MR. TOLMAN.

Dr. Browne also conducted twice weekly a general introductory course (P. H. E.) in the History of English Literature, with readings. Essays have been written monthly, by each member of this class, and have been corrected and commented upon by the instructor.

Professor Corson gave twenty public lectures on the Poetry and Drama of the Restoration Period.

Four class lectures on English Literature at the end of the 15th and beginning of the 16th century, were given by Dr. Wood, who also gave eight public lectures on the literature of the period 1500–1580.

Mr. Woodworth met students daily for training in Vocal Culture.

VII. Romance Languages.

Two advanced courses were conducted by Mr. Elliott during the year. For the first of these the work centred in the Anglo-Norman Dialect, for the second in a study of the earliest Old French Monuments. The following special subjects were treated:

Anglo-Norman:—Chardry's *Josaphas* (XIII century) was taken up and studied in its phonetic relations to earlier works in this dialect, and to the Franco-Norman and the Isle-de-France types. *Weekly, first half-year.*

Old French Seminary:—The Oaths of Strasburg were examined, according to facsimiles of the original MS., in their historical and linguistic relations to the Capitularia Regum and their bearing especially on the earliest development of the Romance system of phonetics. *Weekly, second half-year.*

Low Latin:—An Introduction, through the Inscriptions and Joca Monachorum given in P. Meyer's *Recueil d'Anciens textes Bas-Latins, etc. Second half-year.*

Provençal:—The Boethius Hymn, the Girard de Rossilho Epic, with divers extracts, taken according to age, from the literature of the tenth, eleventh, and twelfth centuries. *Weekly, during the year.*

Old French as Introduction to French Philology:—*Aucassin et Nicolète* with special reference to its phonology and dialect character. *Weekly, first half-year.*

Portuguese:—Os Lusiados de Camões was read, attention being given to Old Portuguese, Old Spanish and Latin forms. *Weekly, first half-year.*

Wallachian:—An Introduction was given in Cionca's *Practische Grammatik der rumänischen sprache* together with extracts from Sionu, Alesandrescu and Alexandri. *Second half-year.*

Ladinian:—The Musso and Valtelline War Epics (XVI and XVII centuries) were read together with selections from the modern literature of Pallioppi, Caderas, Caratsch, and from the Folk Lore. *Weekly, through the year.*

Lectures:—(*a*) On Spanish and Portuguese Dialects, *weekly, through the year;* (*b*) On Comparative Romance Grammar, *weekly, through the year;* (*c*) On French Phonetics, *thirty lectures;* (*d*) On Dante's Divina Commedia, *seven lectures;* (*e*) On the History of the Past Participle in French, *two lectures.*

The students of the French Major Course have read with Mr. Todd:

In Classical (XVII century) French, *Le Cid* (Corneille); *Athalie* (Racine), *L'Avare* (Molière); — In Middle (XVI century) French, the most important selections (considerably more than half) of Darmesteter and Hatzfeld's *Morceaux Choisis des Auteurs du XVI Siècle*, with a *précis* of Middle French Grammar, *twice weekly, first half-year;* — In Old French, the following selections from Bartsch's *Chrestomathie de l'ancien français: Serments de Strasbourg, Cantilène de Ste. Eulalie, La Passion, St. Léger, St. Alexis, Chanson de Roland, Amis et Amiles, Roman de la Rou, Contes del Graal, Roman de Renart, Roman de la Rose, Conqueste de Constantinople, Chroniques de Froissart, Mémoires de Philippe de Comines, Perceforest, twice weekly, second half-year;* — Composition; exercises in style with the use of Gasc's *Prose Composition*. In the second half-year these were supplemented by original essay writing.

The students of the French Minor Course have read with Mr. Todd:

In Literary French, *Le Roi s'amuse*, by Victor Hugo; *Les Demoiselles de St. Cyr* and *Halifax*, by Alexandre Dumas, *père; Le Gendre de M. Poirier*, by Emile Augier and Julés Sandeau; and a part of *La Chanson du Jardinier*, by André Theuriet, *twice weekly;* — In Historical French, one hundred pages of Voltaire's *Histoire du Siècle de Louis XIV, weekly;* — In Scientific French, eighty pages of Milne-Edwards' *Précis d'Histoire Naturelle, weekly*. In connection with the two latter courses the class has studied nearly all of Breymann's French Grammar; — In Syntax and Idioms the class has had recitations and written exercises on the whole of Part I and twenty-five *thèmes* of Part II of Chardenal's *Exercises for Advanced Pupils, weekly*.

Mr. Fontaine has met the students of the Minor Course five times weekly for French conversation, with systematic instruction and drill in the pronunciation.

Mr. Todd has conducted special courses in Spanish and Italian:

The class in Italian have read the following authors: — Silvio Pellico: *Francesca da Rimini* and sixty chapters of *Le Mie Prigioni;* Goldoni: *Un Curioso Accidente, Gl' Innamorati* and *La Sposa Sagace;* and a short *Storia della Letteratura Italiana*. They have further read short selections from Tommaseo, Mamiani, Manzoni, Botta, Leopardi, Alfieri, Tassoni, Tasso, Ariosto, Petrarch, Boccaccio, and others, *twice weekly*. Short exercises in grammar have been given weekly, in connection with the above readings. A special class in Dante have read Cantos V, XII–XXVI of the Inferno, *weekly*.

The class in Spanish have read the following: — Lope de Vega: *El Desdichado por la Honra;* Calderon: *El Alcalde de Zalamea;* and the whole of Knapp's *Spanish Readings, twice weekly*. Short exercises in grammar have been given weekly, in connection with the above.

Two public courses on French Literature including twenty-three lectures and readings (in French) were given by M. Rabillon. He also conducted classes in French conversation.

The JOHNS HOPKINS PHILOLOGICAL ASSOCIATION has met monthly as heretofore. Papers have been read during the session by:

M. BLOOMFIELD.—On certain irregular Vedic subjunctives or imperatives; on a proposed edition of the Kāuçika-sūtra of the Arthava Veda; the probability of the existence of phonetic law.

M. W. EASTON.—Uniformity and analogy.

A. E. EGGE.—On inchoative or *n*-verbs in Gothic and other Germanic dialects.

A. M. ELLIOTT.—The Nahuatl-Spanish dialect of Nicaragua; the development of verbal parasynthetics in *a* in the Romance Languages.

A. EMERSON.—A communication from Prof. E. Wölfflin on the formation of a new Thesaurus Linguæ Latinæ.

B. L. GILDERSLEEVE.—On Ribbeck's life of Ritschl; the Greek final sentence.

J. R. HARRIS.—On the exemplar of codex C and the apocalypse; notes on the Sinaitic and Vatican codices.

J. A. HARRISON.—The syntax of the old past participle and *avoir* in French poetry of the XIIth century.

P. HAUPT.—The Babylonian woman's language.

C. W. E. MILLER.—Rhythmical pronunciation of Greek and Latin prose and a few remarks on accent.

C. D. MORRIS.—The rights of a Greek metropolis over its colonies; on K. Brugmann's recent grammatical studies.

E. G. SIHLER.—Studies in Dinarchus.

E. H. SPIEKER.—Note on a certain use of the Sanskrit word *yathā*.

A. S. TOLMAN.—Musical notation in the study of blank verse.

M. WARREN.—Note on Plautus Mercator.

H. WOOD.—On T. L. Beddoes, a survival of style.

C. B. WRIGHT.—Parallelisms in Beowulf.

The fourth volume of the AMERICAN JOURNAL OF PHILOLOGY has been completed during the year and the first number of the fifth volume has been issued.

HISTORY AND POLITICAL SCIENCE.

PROGRAMME FOR 1884-85.

I. Graduate and Advanced Courses.

1. Seminary of American History and Economics.

The Seminary, to which graduate students only are admitted, will be under the direction of Dr. H. B. Adams, assisted by Dr. R. T. Ely and Dr. J. F. Jameson. The regular weekly meetings of the Seminary are held on Friday evenings, each session occupying two hours. At these meetings oral and written reports are made of original investigations that have been carried on by instructors and students working in definite lines.

During the next year there will be three main lines of inquiry, represented by the three instructors in the department of Historical and Political Science and prosecuted with the co-operation of students. The first line is in continuation of the work followed by Dr. Adams and the Seminary for several years and pertains to American institutions of Government, with special reference to certain local, municipal, state, and national types. The second line of original inquiry, under the direction of Dr. Ely, will be the History of Political Economy in the United States, with reference not only to the progress of the science but to the history of taxation and of economic administration in certain representative cities and States. The third line of investigation will be a study of representative State Constitutions, under the guidance of Dr. Jameson, with special attention to the constitutional history of one or two of the States.

The Seminary library of Historical and Political Science is now well supplied with materials for the prosecution of these researches. The collection of local, municipal, state, and national documents is rapidly increasing; and the necessary authorities, historical and economic, sets of journals, etc., are now at the student's command. In addition to the Bluntschli Library, presented to the Uni

versity by the German citizens of Baltimore and representing the history, politics, and laws of European States, the institutional and economic history of the United States is represented by a good collection of books.

Other libraries, easy of access, are the Library of Congress, the Peabody Library (numbering eighty thousand volumes, well adapted to certain departments of research), the Library of the Maryland Historical Society (especially rich in *Americana*), the Library of the Baltimore Bar (law reports), and the Maryland Episcopal Library (especially valuable for its original sources of church history).

2. History of Politics.

This course, conducted by Dr. H. B. Adams, will be open to graduate and law students only. It will consist of lectures on the History of contemporary European Politics, beginning with the present century, comparative studies in the History of European Institutions from an earlier date, and practical examinations upon select topics of general Political History. *Three times weekly, through the year.*

The following books are recommended to students proposing to follow this course: Plato's Republic, Aristotle's Politics, Cicero's Republic, Dante's De Monarchia, Machiavelli's Writings, Grotius' Works, Montesquieu's Works, Bluntschli's *Geschichte der neueren Staatswissenschaft* and his *Lehre vom modernen Staat*, with the Works of Francis Lieber. Authorities upon topics for oral examination and special research will be named in connection with the lectures.

3. Finance and Taxation.

A course, adapted to students of law, and conducted by Dr. R. T. Ely. The general principles of Finance, Money, and Banking, and also the special subjects of Taxation in the cities and States of the American Union, together with a sketch of the Financial History of the United States, will be considered. *Three times weekly, through the year.*

4. Comparative Studies in European Administration.

A course of lectures by Dr. Ely on Methods of Administration in England, France, and Germany. Special subjects for consideration will be the organization of governments, their economic functions, sanitary legislation, poor laws, appointment and tenure of officers in the civil service. *Once weekly, through the year.*

5. Lectures on the Early Christian Church.

This course will consist of six lectures by Associate Professor J. Rendel Harris, upon the character, organization, charities, and other institutions of the primitive church.

II. Undergraduate Courses.

1. Physical Geography and History.*

After an entrance examination in Physical Geography and in the History of England and of the United States, the student enters upon the following courses, which, in connection with the study of English, are regarded as fundamental to further undergraduate study.

(*a*) Fifteen class exercises introductory to the study of History, with Dr. H. B. Adams. *Once weekly, first half-year.*

(*b*) Fifteen class exercises upon the relation of Physical Geography to History, with Dr. J. F. Jameson. *Once weekly, second half-year.*

(*c*) History of Greece and Rome (Republic and Empire), with Dr. J. F. Jameson. *Twice weekly, through the year*

— or —

Outlines of European History. Freeman's General Sketch of European History will be used as a text-book, with constant reference to other authorities. *Twice weekly, through the year.*

2. Two Years' Course in History.

FIRST YEAR:

Sources of Greek and Roman History.

The first year's course in History is to be taken with Professor C. D. Morris, Dr. Warren, and Dr. Spieker immediately upon entering the University and consists in the reading of ancient historians,—Herodotus, Thucydides, Livy, and Tacitus,—partly in original texts and partly in translations, with special reference to accuracy in interpretation and to historical style. *Five times weekly, through the year.*

SECOND YEAR:

Mediaeval Church and State.

This will be a course with Dr. H. B. Adams in the study of the relations of the Church to the Roman, Frankish, and German Empires. The course will comprise lectures upon ecclesiastical institutions, reports upon assigned themes, and examinations upon Bryce's "Holy Roman Empire," Lea's "Studies in Church History," portions of Milman's "Latin Christianity," and other authorities. *Twice weekly, first half-year.*

The Italian Renaissance and the German Reformation.

This is a continuation of the preceding course and is devoted to the study of the revival of learning, the history of the Italian Republics and their influence upon Europe, the relation of the German Reformation to Italian Humanism, the progress and results of the Reformation. Essays are to be written by the students in connection with this course and frequent oral examinations are held. *Twice weekly, second half-year.*

History of France and England.

This is a course with Dr. J. F. Jameson in the parallel study of the mediæval and modern history of these two countries. Such text-books as "The Student's France" and Green's "Short History of England" are used by the class, and other reading is required in connection with assigned topics. *Three times weekly, through the year.*

NOTE.—For the completion of the two years' course in History, individual examinations are required upon an extended course of private reading, especially recommended to each individual; also the preparation of at least five historical essays, satisfactory in point of substance to the instructor in History, and, in point of style, to the instructor in English.

3. Two Years' Course in Political Science.

FIRST YEAR:

Elements of Political Economy.

A preliminary course of instruction with Dr. R. T. Ely comprising lectures, essays, and frequent examinations upon assigned topics. The basis of class-work will be Laveleye's "Elements of Political Economy" and Cossa's "Guide to the Study of Political Economy," with select portions of the writings of John Stuart Mill and other economists. *Five times weekly, first half-year.*

History of Political Economy.

A more advanced course of lectures by Dr. Ely upon the history of various economic systems, including a consideration of some of the contemporary social problems in England and America. *Five times weekly, second half-year.*

SECOND YEAR:

The English and American Constitutions.

A course with Dr. Jameson in the study of the development and present forms of constitutional government in England and the United States. *Three times weekly, through the year.*

The Modern State System.

A course of instruction with Dr. H. B. Adams upon International Relations, Modern Treaties (including those of the United States) and Modern Politics, preparatory to the study of International Law as embodied in Bluntschli's German Code. *Twice weekly, through the year.*

NOTE.—The first year in Political Science is to follow the first year's course in History and is taken in connection with the historical courses on Church and State; Renaissance and Reformation; France and England. In no case can two years' work either in History or Political Science be taken together in one year; but, in cases where only one year can be devoted to these subjects, a half-year in History may be combined with a half-year in Political Science. A year in History may also be combined with a year in Political Science. For the completion of the full undergraduate course in Political Science a prescribed amount of private reading must be offered.

* Part of what is called the P. H. E. course, required of all undergraduates, and comprising Physical Geography, History, and English.

WORK OF THE PAST YEAR, 1883-84.

I. Seminary Work.

A. American Institutions and Economics.

The Seminary of Historical and Political Science has met regularly once a week for a session of two hours under the direction of Dr. H. B. Adams. During the past year, attention has been directed especially to the study of American Institutions and American Economics, with reference to specific topics suggested by the instructors in those departments of study.

Among the original papers presented and discussed by members of the Seminary are the following: The Seminary Method, by H. B. Adams; Christian Socialism, by R. T. Ely; Étienne Cabet and his Icarian Community, by Albert Shaw (Doctor's thesis, 1884); Virginia Institutions (three papers), by Edward Ingle; Judicial Procedure among Boys, by John Johnson; State and Local Taxation in Kentucky, by Arthur Yager (Doctor's thesis, 1884); Congressional Government, by Woodrow Wilson.

B. American Colonial History, by Dr. H. B. Adams.

An extra session of the Seminary, one hour a week through the year, has been devoted to the study of the sources of American Colonial History and to the prosecution of certain lines of research suggested by the instructor.

Attention was first called to the history of American discoveries and to early American cartography. The first settlements of Virginia, of New England, and of other colonies were then investigated. Papers were prepared by students upon such subjects as the following: the Spaniards in Florida, the Swedes on the Delaware, the Economic Beginnings of Pennsylvania, the Institutional History of Pennsylvania, the Beginnings of Connecticut, the Institutions of Virginia, Maryland, California and the Southwest, Oregon and the Northwest, etc. Some of this Seminary work will be elaborated into studies suitable for publication. Particular attention was called by the instructor to the development of federal unity among the colonies. The phases of union before the Continental Congress were considered in detail, and some new lines of inquiry were pointed out.

II. Historical and Political Science Association.

In connection with the Seminary, which consists of graduate students devoting their chief attention to History and Economics in this University, is an Association including a few honorary and non-resident members, not directly connected with this institution.

Among those who have addressed the Association during the past year are: Dr. H. Von Holst, on Slavery as an Institution; James Bryce, M. P., on De Tocqueville's Democracy in America; Dr. Charles Gross, on the Guild Merchant, — an Introduction to American Municipal History; Major J. W. Powell, Chief of the Ethnological Bureau, on Indian Institutions; Dr. E. Channing (Harvard), on Town and County Government; Dr. J. Royce (Harvard), on the Development of Society and Government in California.

Among the original papers forwarded to the Association by non-resident members are: Indian Money in New England Civilization, by W. B. Weeden, and Town Government in Rhode Island. by W. E. Foster.

III. Publications.

Some of the principal papers presented to the Seminary or to the Historical and Political Science Association are published in the Johns Hopkins University Studies in Historical and Political Science, a monthly monographic journal, edited by Dr. H. B. Adams. The first volume, devoted to Local Institutions and comprising 470 pages, was completed in October, 1883.

The First Series is devoted, to "American Institutional History," more especially to forms of Local Government. A Second Series, devoted to Local Institutions and American Economics is now in progress. Among the monographs in this volume are Professor Hosmer's, on "Town Meetings"; Professor Macy's, on "The Institutional Beginnings of a Western State (Iowa)"; Dr. L. W. Wilhelm's "Old and New Towns in Maryland"; Dr. R. T. Ely's "Past and Present of Political Economy"; Dr. Henry Carter Adams's "Taxation in the United States, 1789-1816" (Doctor's thesis, J. H. U.) Many of the contributions to the Seminary and Association are published through other channels than the University Studies, *e. g.*, in the Proceedings of Historical Societies, in the Magazine of American History, etc.

IV. Advanced and Collegiate Classes.

DR. H. B. ADAMS.

1. Historical Development of International Law.

An advanced course, three hours weekly, first half-year, introductory to the study of Bluntschli's *Völkerrecht* in the German text.

The instructor lectured upon the beginnings of international life as illustrated in ancient and mediæval history. He considered such topics as the inter-tribal and inter-municipal relations of the Orient; the inter-municipal institutions of the Greeks; the international influence of Rome and of the Christian Church; the Italian beginnings of modern international law; and the rise of the state system. In connection with this historical survey of the growth of internationalism, various special papers were presented by members of the class, upon such subjects as Carthaginian treaties, the Roman municipal system, the municipal leagues of the middle ages, etc. In connection with the reading and exposition of Bluntschli's code, a great variety of practical questions pertaining to international politics were discussed by individuals, *e. g.*, France in the Tonquin, the opening of China, the progress of Japan, the control of the Congo, international congresses and tribunals, the Panama Canal, the Monroe doctrine, etc.

2. The Old German Empire and the Rise of Prussia.

This was an advanced course, three hours a week, second half-year, after the conclusion of the course on International Law.

Lectures were given upon mediæval Germany, the origin and development of Prussia, its territorial and dynastic history, its relation to the break-up of mediæval unity and to the re-constitution of Germany. The course was designed to be introductory to the study of European Constitutions and Continental Politics, which subjects will be pursued during the next academic year. In connection with the lectures, oral examinations were instituted upon general topics of European history, which practical exercises will be continued during the coming year.

3. The Beginnings of Church and State.

An undergraduate course, twice a week, first half-year. The course consisted of lectures by the instructor and oral reports by members of the class, in which exercises ten graduate students participated. The instructor considered the origin and spread of Christianity, its relations to the Roman empire and the Germanic peoples; the origin and growth of ecclesiastical institutions, — bishops, presbyters, synods, councils, etc.; the history of the papacy in the middle ages; and the Holy Roman Empire. The students prepared essays and reports upon topics connected with the course and were examined upon the lectures, together with certain prescribed authors,—Bryce, portions of Gibbon, Milman, and Ploetz's Epitome.

4. The Italian Renaissance.

A continuation of the above undergraduate course, two hours a week, second half-year. The course consisted chiefly of lectures upon the history of the Italian republics, the revival of learning and of art, and the relations of Italian to European history. Reading was required in such authors as Burckhardt, Symonds, Grimm, and Hallam; reports were prepared upon assigned topics.

5. Introductory Historical Course.

Twelve lectures to undergraduates entering upon the course in Physical Geography, History, and English.

DR. R. T. ELY.

6. Advanced Course in Political Economy.

This course, three hours weekly, throughout the year, consisted of class-lectures, student-lectures, and occasional special lectures.

The subjects to which particular attention was devoted were as follows: The Historical Development of Economic Theory; the Fundamental Principles of Political Economy, including definitions; Production; Value and Price; Distribution and Consumption; the means of Transportation and Communication; Free Trade and Protection; Social Movements in America. Each student read a paper on some phase of economic history and a number of essays were prepared on the History of Political Economy in the United States. A paper was also read on Taxation in Baltimore, and a careful study of Taxation in Pennsylvania has been begun. An essay on "Icaria, a chapter in the History of American Communism," was prepared and part of it read before the class. This essay by Dr. Albert Shaw is now in press and will be published in book-form by Messrs. G. P. Putnam's Sons.

7. Minor Course in Political Economy.

The first part of this course consisted of lectures on the Elements of Political Economy and a careful study of John Stuart Mill's Principles of Political Economy, with frequent reference to Walker's "Political Economy," and other works. The second part consisted of lectures on Historical Systems of Political Economy. At least two papers were prepared and read by each member of the class. A few of the subjects treated were as follows: The Wage-Fund Theory; Trades Unions and Strikes; The Internal Revenue of the United States; the Income Tax; Communistic Experiments in the United States; The Independent Treasury System of the United States; the Theory of Value.

DR. J. F. JAMESON.

8. History of England and France.

This course, three hours weekly throughout the year, formed, with Dr. Adams's undergraduate work, the minor course in History. Green's England and Masson's Guizot's France were used as text-books. The recitations were accompanied by informal lectures. Reports upon topics, specially assigned, and studied under the direction of the instructor, were made. Additional reading in the standard authors was required. Formal lectures brought the course down to the present time.

9. History of Greece and Rome.

Twice weekly throughout the year. Text-books were used, informal and occasionally formal lectures were given, and selected topics were reported upon.

10. English Constitutional History.

Once a week. Stubbs' "Select Charters and other Documents illustrative of English Constitutional History" was used; the period studied was that from 1066 to 1216, special attention being paid to the development of the principles established by Magna Charta.

11. Physical Geography.

Lectures on the relations of Physical Geography to History (with special reference to Greece and Italy) were given once a week, beginning in January.

Courses of public lectures were also given in Hopkins Hall:—on the Relation of History and Politics, by Professor H. VON HOLST, of the University of Freiburg, and on the Study of Roman Legal History, by Professor JAMES BRYCE, of the University of Oxford.

PHILOSOPHICAL COURSES.

PROGRAMME FOR 1884-85.

A. For Advanced and Special Students.

PSYCHOLOGY AND PEDAGOGICS.

PROFESSOR G. STANLEY HALL will direct the studies of all advanced students who wish to take up the study of Psychology or Pedagogy upon the following plan.

1. He will lecture twice a week in the Biological Laboratory on Psycho-Physiology. Though in the main, a continuation of the course begun in February, 1884, these lectures will be open to other graduate students who have heard Professor Martin's course in animal physiology or done work elsewhere which can be accepted as its equivalent.

Beginning with compound reflex-action and instinct in animals, such topics as memory, association of ideas, attention, volition and feeling in their morbid and normal forms will be discussed as far as possible on a physiological basis. The contributions of psycho- and neuro-pathology to the understanding of the normal function and histology of the cerebro-spinal nervous system will receive special attention. In connexion with this part of the course demonstrative and observational exercises in human neurology will be offered to those who desire them. The psychology and pathology of speech and writing will be illustrated. The psychological parts of anthropology, the evolution of the psychic faculties in children and in the race, etc., will be summarized and will introduce the psychology of national and other comprehensive systems of opinion and thought. In short, the endeavor will be to give as briefly as possible a general survey of the vast field of modern scientific psychology, with such details, demonstrations and illustrations as the time will permit.

This course is intended:

For those who desire to carry on the study of biology by experimental methods into the study of the psychic functions of animals and man:

For those intending to give attention to the study of psychiatric medicine:

For those interested in medical jurisprudence or in linguistic psychophysics:

For special students of philosophy.

2. He will encourage and direct Psycho-Physic research with carefully selected original themes approved by him, with a view apart from results, to the educational significance of these methods as a field of applied logic.

3. He will lecture once weekly on the History of Modern Philosophical and Educational Ideas, beginning with the scholastic period.

The views of representative modern philosophers will be sketched; and, as the basis of educational ideas necessitates a broader survey, selected chapters from the history of science, medicine, and belief will be added. In tracing the application of these to education in the broader and higher sense, such topics will be discussed as *e. g.*, the organization and operation of learned societies and scientific and other academies; the constitution and methods and history of European universities from the Renaissance; the educational value of philosophical systems; professional schools of law, medicine, theology, technological and industrial

schools; the French, English, German, and American school and college system in their method and idea; the development and nature of student life; history and theory of examinations and degrees and academic festivals and traditions; special methods and problems of pedagogics at the present time.

These lectures are especially designed to serve:

Those graduate students desiring to become teachers or professors:

Students of history, and more particularly of philosophical and educational opinion and method or those intending to plead or preach:

Those intending to teach philosophy.

4. He will hold a weekly conference during a part of the year at which others whose names are to be announced later will assist.

5. In connection with the work of the above courses, rooms, apparatus, and books are to be provided, and bibliographies of a special and descriptive kind will be printed as guides to reading and reference.

HISTORY OF PHILOSOPHY AND ETHICS.

PROFESSOR G. S. MORRIS will give the following courses:

1. Lectures on the History of Philosophy in Greece.

Twice weekly, first half-year.

Topics involved:—

The beginnings of science. Anticipations of the modern doctrine of development. Establishment of elementary conceptions of physical science. First application of mathematical conceptions to the comprehension of the universe. Beginnings of abstract speculation. First successful development of concrete or substantial idealism, including science of method (logic), and philosophy of nature, man, the State, art, and education. Systems of practical philosophy.

2. Ethics, or the Science of Man.

Two lectures weekly, first half-year.

A consideration of the foundations and content of ethical science, together with an historical survey.

Topics involved:—

The different forms of science. Relation of ethics to anthropology, physiology, and psychology. The distinction and the concrete unity of body, soul, and spirit. Ethics proper, the science of man as practical intelligence. Man prefigured in nature. Self-consciousness. Its relation to animal instinct. Its realization in the moral organisms of family, State, and religion. Conscience. Will. The good of man: Happiness or pleasure? Character. The system of virtues and duties. The types of ethical opinion, as illustrated in the ancient and modern history of philosophy.

3. Professor Morris will further be prepared, according as the demands or needs of students may require, to lecture on the lessons of Modern Philosophy, the philosophy of the State (with special reference to Aristotle, Hobbes, Hegel, and Spencer), or "Real Logic" ("Metaphysics,"—with special reference to Aristotle, Leibnitz, and later German Philosophers).

BOOKS OF REFERENCE.

COURSE I:—1. Mullach, *Fragmenta Philosophorum Graecorum*;—2. Ritter et Preller, *Historia Philosophiæ Graeco-Romanæ ex fontium locis contexta*;—3. The works of Plato and Aristotle;—4. E. Zeller, *Geschichte der griechischen Philosophie, (German and English translation)*;—5. Ueberweg, *History of Philosophy, Vol. I*;—6. Noack, *Philosophie-geschichtliches Lexikon*;—7. Numerous monographs on special topics (to be found in the Library of the University and in the Peabody Library)

COURSE II:—1. I. H. Fichte, *System der Ethik*, 1 Band: *Geschichte der Ethik*;—2. H. Sidgwick, Historical Article on "Ethics," Encyclopaedia Britannica, 9th edition;—3. Aristotle, *Nicomachean Ethics*;—4. Martensen, *Christian Ethics*;—5. Spinoza, *Ethica*;—6. Bishop Butler, *Sermons*;—7. Kant, *Ethical Works*;—8. Fichte, *Works*;—9. Hegel, *Philosophie des Geistes*;—10. J. S. Mill, *Utilitarianism*;—11. H. Spencer, *Data of Ethics*;—12. H. Sidgwick, *Methods of Ethics*;—13. F. H. Bradley, *Ethical Studies*;—14. T. H. Green, *Prolegomena to Ethics*.

B. Course Required of all Matriculated Students.

This course will comprise five hours per week throughout the year, and includes Logic, Ethics, and Psychology (hence known as the L. E. P. Course). A special instructor will be appointed to assist under Dr. Hall's direction in this work, which will consist of lectures, recitations, themes, epitomes, etc. These subjects will be taken up in the following order.

1. Inductive and Deductive Logic.

Text-books: Fowler, with references to Jevons, Mill, Venn, Sigwart, and Wundt.

2. General Psychology.

Text-books: Sully's Psychology in selections, with references to Porter, Ryland, Carpenter.

3. Positive and Practical Ethics.

This part of the course will be taught in part by lectures and will comprise such topics as mental and physical regimen and hygiene, methods and general ends of study, the needs and sanctions of positive personal convictions and purposes in the conduct of the understanding and of life, mental self-knowledge as opposed to self-consciousness, and the utilization of individual experience in self-education, social ethics, need of religious sentiments for the maturity and sanity of conscience, etc.

Books of reference: Maurice's *Social Morality*, Grote's *Treatise on the Moral Ideals*, Wuttke's *History of Christian Ethics*, Wayland's *Moral Philosophy*, Calderwood's *Moral Science*.

4. In addition to the above required courses, a series of lectures will be given by Dr. Hall, during the latter part of the year intended at once to conclude matriculate and introduce advanced study of philosophy.

WORK OF THE PAST YEAR, 1883-84.

Philosophy.

PROFESSOR G. STANLEY HALL lectured twice a week through the second half-year on Psycho-physics.

The course was mainly devoted to the physiology of the senses, cerebro-spinal localization and attention, as introductory to a course on psychology, beginning with instinct, during the coming year. Demonstration work was done and courses of reading posted.

Six advanced students engaged in special investigations in the room set apart for psycho-physic research and results were obtained that will be published later.

Dr. Hall lectured twice a week on psychological ethics, mainly historical, beginning with ethical conceptions and theories of the Greeks and concluding with Kant, and considerable attention was given to inductive methods of studying ethical problems.

He also gave twelve lectures to the matriculate students on Mental Hygiene.

PROFESSOR G. S. MORRIS gave during the first half-year:

1. A course of three lectures weekly on the History of Philosophy in Germany, with special reference to the movement from Kant to Hegel.

The beginnings and the general character of the history of modern philosophy were first briefly sketched; the doctrines of Descartes, Spinoza, and Leibnitz were described in greater detail; and then, after a summary account of the philosophical situation in Germany prior to Kant, the doctrines of Kant were analyzed, with special reference to the unity of the three *Critiques*, and to the comprehension of the fundamental problems of philosophy, as

anew presented by Kant, (1) in the light of the results of ancient philosophy, and (2) with reference to the further treatment of these problems by the successors of Kant. This course was designed for advanced students.

2. A Seminary course, for the most advanced students only, was conducted, the subject of study being Spinoza's *Ethics*. The work in this course was restricted especially to the first, second, and fifth parts of Spinoza's masterpiece.

The object of the study was to attain an exact knowledge of the nature of Spinoza's fundamental conceptions and of his method, to estimate their value and significance in the light of the larger historic results of philosophic inquiry, and, in some measure, to consider their relation to the fundamental conceptions of modern science. In accordance with the Seminary method, the different members of the class by turns took the lead in the analytic exposition of the text and criticism of the argument.

3. An outline of the general History of Philosophy, both ancient and modern, was given in a series of two lectures weekly, throughout the first half-year.

This was intended for undergraduates and others desiring to take advantage of such a course. Members of the L. E. P. course were required to listen to and be examined on twelve lectures relating to modern philosophers.

4. A course of four public lectures on the Philosophy of Social Relations, was also given by Professor Morris.

MR. C. S. PEIRCE gave a course of lectures in Mathematical Logic, twice weekly through the year; a course in Philosophical Terminology, weekly during the first half-year; and a course in Probabilities, twice weekly during the second half-year.

He also guided a company of students in studying the psychology of great men.

MR. HARRIS gave an elementary course in Logic during the first half-year and a course in Practical Ethics during the second half-year.

Two public lectures on the Religious Aspect of Philosophy were given by Dr. Josiah Royce, of Harvard College.

A course of lectures upon educational topics was given on Saturday mornings to a company of about eighty graduate students who were preparing themselves for the work of teachers in colleges and high schools. Lectures were given by President Gilman, Professors Gildersleeve, Remsen, Martin, Hall, Doctors Adams and Wood, and Mr. Peirce.

CONFERRING OF DEGREES.

JUNE 5, 1884.

The Commencement exercises of the Johns Hopkins University took place on Thursday, June 5, 1884. The ceremonies were attended by a large company, consisting of the trustees and instructors of the University, and the friends of the graduates.

An address to the graduates was made by President Gilman. In this he considered the attitude which the young men should take in respect to Education, Politics, and Religion.

Professor C. D. Morris, on behalf of the Board of Collegiate Advisers, presented the candidates for the degree of Bachelor of Arts, and that degree was conferred on the persons named in the following list.

The candidates for the degree of Doctor of Philosophy were presented by the heads of the respective departments of study on behalf of the Board of University Studies, and the degree was conferred on the persons named in the following list.

After the close of the exercises in Hopkins Hall, there was a social assembly of the graduates and their friends in the new Gymnasium.

Doctors of Philosophy.

HERBERT WILLIAM CONN, of Fitchburg, Massachusetts, A. B., Boston University, 1881. His principal subject has been Animal Morphology, the subsidiary, Animal Physiology and Histology. His thesis on the "Life-History of Thalassema Millita" has received one of the Walker prizes of the Boston Society of Natural History.

ELLERY WILLIAM DAVIS, of Oconomowoc, Wisconsin, S. B., University of Wisconsin, 1879. His principal subject has been Mathematics, the subordinate, Physics. He submitted a thesis on the "Parametric Representation of Curves."

DAVID TALBOTT DAY, of Baltimore, A. B., Johns Hopkins University, 1881. His principal subject has been Chemistry, the subordinate, Physics. He submitted a thesis on the "Changes effected by Heat in the constitution of Ethylene."

JOHN DEWEY, of Burlington, Vermont, A. B., University of Vermont, 1879. His principal study has been Philosophy, the subsidiary, Political Science. He submitted a thesis on the Psychology of Kant.

JAMES REYNOLDS DUGGAN, of Macon, Georgia, A. B., Mercer University, 1877, and M. D., Jefferson Medical College, 1879. His principal subject has been Chemistry, the subordinate, Biology. He submitted a thesis on "Fermentation."

WILLIAM HENRY HOWELL, of Baltimore, A. B., Johns Hopkins University, 1881. His principal subject has been Animal Physiology and Histology, the subordinate, Chemistry. He submitted a thesis entitled "Experiments upon the Blood and Lymph of the Terrapin, and the origin of the Fibrin formed in Coagulation.

HANS CARL GÜNTHER VON JAGEMANN, of Naumburg, Germany, a graduate of the Naumburg Gymnasium. His principal subject has been the Romance Languages, the subordinate, English and German. He submitted a thesis on the "Anglo-Norman Vowel System in its relations to the Norman words in English."

EDWARD HARRISON KEISER, of Allentown, Pa., B. S., Swarthmore College, 1880. His principal study has been Chemistry, the subordinate, Physics. His thesis was on "The Existence of Active Oxygen."

ARTHUR LALANNE KIMBALL, of Plainfield, N. J., A. B., Princeton College, 1881. His principal subject has been Physics, the subsidiary, Mathematics. He submitted a thesis on the "Value of the B. A. Unit of Electrical Resistance in Absolute Measure."

HENRY LESLIE OSBORN, of Madison, N. J., A. B., Wesleyan University, 1878. His principal subject has been Animal Morphology, the subsidiary, Animal Physiology and Histology. His thesis on "The Gill in some forms of Prosobranchiate Mollusca" has already been printed in the Studies from the Biological Laboratory.

CHARLES ALBERT PERKINS, of Ware, Mass., A. B., Williams College, 1879. His principal subject has been Physics, the subordinate, Chemistry. He submitted a thesis on the "Variation of the Magnetic Permeability of Nickel at different temperatures."

ALBERT SHAW, of Grinnell, Iowa, A. B., Iowa College, 1879. His principal study has been History, the subordinate, Political Science. His thesis entitled "Étienne Cabet and the Icarian Community," is to be published in book-form by G. P. Putnam's Sons, New York.

HENRY NEWLIN STOKES, of Moorestown, N. J., S. B., Haverford College, 1878. His principal subject has been Chemistry, the subsidiary, Animal Physiology and Histology. His thesis was on "The nature of the Sulphinide obtained by oxidizing *a*-Naphthalene-sulphamide.

LEWIS WEBB WILHELM, of Baltimore, A. B., Johns Hopkins University, 1880. His principal subject has been History, the subordinate, Political Science. His thesis, entitled "Sir George Calvert, Baron of Baltimore," has been read before the Maryland Historical Society, and accepted for publication.

ARTHUR YAGER, of Georgetown, Ky., A. B., Georgetown College, 1879. His principal subject has been History, the subsidiary, Political Science. He submitted a thesis on "State and Local Taxation in Kentucky."

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Bachelors of Arts.

ALBERT CLAYTON APPLEGARTH, of Baltimore, a former student of the City College.
Principal Studies: Chemistry and History;—German, Mathematics, and Political Economy.

CHARLES WALTER ARTZ, of Hagerstown, Maryland, who pursued his preliminary studies under Mr. J. T. Carlile.
Principal Studies: German and Political Science;—Physics, History, French, and English.

WALTER BLISS CANFIELD, of Baltimore, who pursued preparatory studies under Mr G. G. Carey.
Principal Studies: History and Political Economy, and Latin;—French, Greek, and Chemistry.

GEORGE GIBSON CAREY, JR., of Baltimore, who pursued his preliminary studies with Mr. G. G. Carey.
Principal Studies: History and Political Economy, and Latin;—Physics, German, and French.

WILLIAM KENNEDY CROMWELL, of Baltimore County, who pursued preparatory studies with Mr. H. W. Luckett.
Principal Studies: History and Political Economy, and German;—Chemistry, Latin, and French.

CHARLES WILLIAM RAMMELSBERG CRUM, of Jefferson, Maryland, a former student of Franklin and Marshall College.
Principal Studies: Mathematics and Physics;—English, French, and German.

HARRY FRIEDENWALD, of Baltimore, a former student of the City College.
Principal Studies: Biology and Chemistry;—French, Philosophy, and Physics, with English and History.

WILLIAM LINDSAY GLENN, of Baltimore, who pursued his preliminary studies under Mr. G. G. Carey.
Principal Studies: Latin and Greek;—French and Physics, with English, Ethics, and History.

JOHN HINKLEY, of Baltimore, who pursued preparatory studies with Mr. G. G. Carey.
Principal Studies: History and Political Economy, and Latin;—German, French, Chemistry, and Physics.

CHARLES HOWARD HOWARD, of Baltimore, who pursued his preliminary studies with Mr. W. S. Marston.
Principal Studies: History and Political Science, and Greek;—Physics, Latin, and Logic, with English and Ethics.

JOHN DEERING LORD, JR., of Baltimore, who pursued preparatory studies with Mr. M. A. Newell.
Principal Studies: History and Political Economy, and Latin;—Physics, French, and German.

JERE WILLIAMS LORD, of Baltimore, who pursued preparatory studies under Mr. M. A. Newell.
Principal Studies: Biology and Chemistry;—Physics, English, and French, with Logic, Ethics, and Psychology.

WILLIAM PATRICK LYONS, of Baltimore, a former student of Loyola College.
Principal Studies: French and History;—Latin, Philosophy, Physics, and German.

EDGAR GEORGE MILLER, JR., of Baltimore, who pursued his preliminary studies under Mr. L. V. Tuttle.
Principal Studies: History and Political Economy, and German;—Latin, Greek, Physics, and Chemistry.

WILLIAM RIDGELY ORNDORFF, of Baltimore, a graduate of the City College in 1881.
Principal Studies: Chemistry and German;—French and Physics, Logic and Psychology, English and History.

GEORGE DOBBIN PENNIMAN, of Howard County, a former student of the City College.
Principal Studies: History, Philosophy, and German;—French, Latin, and Physics.

WILLIAM H. PERKINS, of Baltimore, who pursued preparatory studies with Mr. W. S. Marston.
Principal Studies: Mathematics and French;—Latin, German, and Physics.

GEORGE CLEMENT STOKES, JR., of Govanstown, Maryland, who pursued his preliminary studies with Dr. J. C. M. Mérillat.
Principal Studies: History and Political Science, and German;—Physics and Latin, Logic, Ethics, and Psychology.

WILLIAM JONES THOMAS, of Baltimore, a former student of Randolph Macon College.
Principal Studies: Mathematics and History;—German, Latin, and Physics.

WILLIAM FERDINAND WALZ, of Baltimore, a graduate of the City College in 1881.
Principal Studies: Greek and Latin;—French, Chemistry, and History.

FREDERICK HENRY WILKENS, of Baltimore, who pursued his preliminary studies under Mr. E. M. Lamb.
Principal Studies: Greek and Latin;—German, English, and Chemistry, with History and Ethics.

GEORGE WISHART EDMOND, of Portland, Maine, a former student of Amherst College.*

CHARLES HOWARD SHINN, of San Francisco, California, a former student of the University of California.*

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*On these two gentlemen, who had pursued studies here, the Board of Collegiate Advisers recommended that the degree should be conferred *extra ordinem*, since the Board had satisfactory evidence of their good attainments in many branches of a liberal education.

The Johns Hopkins University Circulars are printed by Messrs. JOHN MURPHY & CO., 182 West Baltimore Street, Baltimore, from whom single copies may be obtained. They may also be procured, as soon as published, from Messrs. CUSHINGS & BAILEY, No. 262 West Baltimore Street, Baltimore.

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CALENDAR, 1884–85.

Tuesday, September 23.	**Academic Year Begins.**
Tuesday, September 23.	**Examinations for Matriculation Begin.**
Tuesday, September 30.	**Instructions Resumed.**
Friday, June 12.	**Academic Year Closes.**

CONTENTS.

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NOTES AND COMMUNICATIONS.

MATHEMATICS.

Equations in Matrices. By J. J. SYLVESTER.

[Extract of a letter from Professor Sylvester to Dr. F. Franklin].

I have been lately considering the subject of equations in matrices. Sir William Hamilton in his "Lectures on Quaternions" has treated the case of what I call unilateral equations of the form $x^2 + px + q = 0$, or $x^2 + xp + q = 0$, where we may, if we please, regard x, p, q as general matrices of the second order. He has found there are six solutions, which may be obtained by the solution of an ordinary cubic equation. In a paper now in print and which will probably appear in the May number of the *Philosophical Magazine*, I have discussed by my own methods the general *unilateral* equation, say

$$x^\omega + px^{\omega-1} + qx^{\omega-2} + \ldots + l = 0,$$

where $x, p, q \ldots l$, are quaternions or matrices of the second order, and have shown, by a method satisfactory if not absolutely rigorous, that the number of solutions is $\omega^3 - \omega^2 + \omega$, that is to say, the nearest superior integer to the general maximum number of roots (ω^4) divided by the augmented degree $(\omega + 1)$.

But after I had done this it occurred to me that there were multitudinous failing cases of which neither Hamilton nor myself had taken account, as *ex. gr.* $x^2 + px = 0$, besides the solutions $x = 0$, $x = -p$, will admit of a solution containing an arbitrary constant, I think; but that is a matter which I shall have to look further into before committing myself to a positive assertion about it. I have only had time to pass in review the more elementary case of a unilateral simple equation, say $px = q$, where p, q are matrices of any order ω.

If p is non-vacuous there is one solution, viz.; $x = p^{-1}q$; but suppose p is vacuous: what is the condition that the equation may be soluble?

1°. Suppose $q = 0$, p being vacuous has for its identical equation $pP = 0$, and consequently we may make $x = \lambda P$ where λ is an arbitrary constant.

2°. Suppose q is finite and that $x = r$ is one solution, then obviously the general solution is $x = r + \lambda P$.

We have now to inquire what is the condition that r may exist. I find from the mere fact of x being indeterminate (and confirm the result by another order of considerations) that the determinant of $q + \lambda p$ must vanish identically; so that for instance when p, q are of the second order and $\begin{matrix} b & c \\ d & e & f \end{matrix}$ are the *parameters to the corpus* (p, q), we must have when $d = 0$, which is implied in the vacuity of p, $f = 0$ and $e = 0$. The first of these conditions is known *à priori* immediately from my third law of motion; but not so, without introducing a slight intervening step, the intermediate one (I mean the connective to d and f, viz.) $e = 0$.

So in general in order that $px + q = 0$ may be soluble, *i. e.* in order that $p^{-1}q$ where p is simply vacuous may be *Actual* and not Ideal, q must satisfy as many conditions as there are units in the order of p or q, all implied in the fact that the determinant to $p + \lambda q$, where λ is an arbitrary constant, vanishes identically. When these conditions are satisfied $p^{-1}q$ becomes actual but indeterminate. (This, by the way, shows the disadvantage of calling a *vacuous* matrix *indeterminate*, as was done in the infancy of the theory by Cayley and Clifford—for we want this word as you see to signify a combination of the inverse of a vacuous matrix with another which takes the combination out of the ideal sphere and makes it actual).

So in general in order that $p^{-1}q$ where p is a null of the ith order (*i. e.* where all the $(i+1)$th but not all the ith minors of p are zero) shall be an actual (although indeterminate) matrix, it is necessary and sufficient that $p + \lambda q$, where λ is arbitrary, shall be a null of the same (ith) order. What will be the degree of indeterminateness in $p^{-1}q$, *i. e.* how many arbitrary constants are contained in the value of x which satisfies the equation $px = 0$ remains to be considered.

The law as to the conditions is an immediate *corollary* to my third law of motion, for if $px = q$ then $p + \lambda q = p\,(1 + \lambda x)$; consequently $p + \lambda q$, whatever λ may be, must have at least as high a degree of nullity as p. Q. E. D.

Oxford, April 12, 1884.

Note on Peirce's Linear Associative Algebra. By A. CAYLEY.

I find that to the double systems given by Peirce, viz.,

$$(a_2)\quad \begin{array}{c|cc|} & x & y \\ \hline x & x & y \\ \hline y & y & 0 \\ \hline \end{array} \qquad (b_2)\quad \begin{array}{c|cc|} & x & y \\ \hline x & x & y \\ \hline y & 0 & 0 \\ \hline \end{array} \qquad (c_2)\quad \begin{array}{c|cc|} & x & y \\ \hline x & y & 0 \\ \hline y & 0 & 0 \\ \hline \end{array}$$

should be joined

$$(d_2)\quad \begin{array}{c|cc|} & x & y \\ \hline x & x & 0 \\ \hline y & y & 0 \\ \hline \end{array}.$$

To show that this is really distinct from (b_2), observe that starting from (b_2) and writing $z = ax + \beta y$, we have $z^2 = a^2x^2 + a\beta(xy + yx) + \beta^2y^2 = a^2x + a\beta y$, $= a(ax + \beta y)$: whence in (b_2), $z = x + \beta y$, β arbitrary, is the only idempotent symbol, and y is the only nilpotent symbol. And z having this value $= x + \beta y$, we have $z^2 = z$, $zy = y$, $yz = 0$, $y^2 = 0$; viz., in (b_2) introducing the general symbol z in place of x, the system in z, y retains its original form: that is, we cannot in anywise transform (b_2) into (d_2). I have further considered the question in a paper communicated to the London Mathematical Society but not yet published.

Cambridge, England, May 12, 1884.

On the Equations which determine the Axes of a Quadric Surface. By W. E. STORY.

[Abstract of a communication to the University Mathematical Society, May 21, 1884].

If $u_1, u_2, u_3, \ldots, u_n$ are homogeneous point (or tangential) coordinates in an $(n-1)$-fold space, and

$$U_{uu} \equiv \textstyle\sum_i \sum_k b_{ik} u_i u_k = 0 \qquad (b_{ik} = b_{ki})$$

is the equation of the absolute, where the summation extends to all integral values of i and k from 1 to n, inclusive; the coordinates of the centres (or principal sections) of the quadric surface whose equation is

$$P_{uu} \equiv \textstyle\sum_i \sum_k a_{ik} u_i u_k = 0 \qquad (a_{ik} = a_{ki})$$

are determined by the equations

$$(1) \qquad \textstyle\sum_i a_{ik} u_i = \lambda \sum_i b_{ik} u_i,$$

being n equations corresponding to the values $k = 1, 2, 3, \ldots, n$ respectively, in which λ is a parameter whose value is determined by the condition that equations (1) shall be coexistent for some set of values of the u's, *i. e.* by the vanishing of the determinant of the n-th order whose constituents are $a_{ik} - \lambda b_{ik}$. Let

$$P_{vw} \equiv \textstyle\sum_i \sum_k a_{ik} v_i w_k, \qquad Q_{vw} \equiv \sum_i \sum_k b_{ik} v_i w_k,$$

then $Q_{vw} = 0$ is the condition that the two points (or planes) v and w shall be mutually perpendicular and $Q_{v\sigma} Q_{w\tau} - Q_{v\tau} Q_{w\sigma} = 0$ is the condition that the lines joining the points vw and $\sigma\tau$ respectively (or the intersections of the planes vw and $\sigma\tau$ respectively) shall be mutually perpendicular. Now let $\mu, v_1, v_2, \ldots, v_n$ and $\nu, w_1, w_2, \ldots, w_n$ be any two different sets of solutions of equations (1), so that μ and ν are different, then

$$(2) \qquad \textstyle\sum_i a_{ik} v_i = \mu \sum_i b_{ik} v_i, \qquad \sum_i a_{ik} w_i = \nu \sum_i b_{ik} w_i;$$

operating on the first set of these equations with $\sum_k w_k$ and on the second set with $\sum_k v_k$ we obtain, on account of the symmetry of P_{vw} and Q_{vw},

$$(3) \qquad P_{vw} = \mu Q_{vw}, \qquad P_{vw} = \nu Q_{vw},$$

and hence, since μ and ν are different,

$$(4) \qquad P_{vw} = 0, \qquad Q_{vw} = 0,$$

i. e. any two different centres (or principal sections) of a quadric are mutually perpendicular. The axes of a quadric are the lines joining the centres (or intersections of the principal sections), and if v, w, σ, τ are centres (or principal sections) of which at least three are different, we have, by (4),

$$Q_{v\sigma} Q_{w\tau} - Q_{v\tau} Q_{w\sigma} = 0,$$

i. e. any two axes of a quadric are mutually perpendicular.

Some Remarks on Unicursal Curves. By E. W. DAVIS.

[Read at a meeting of the University Mathematical Society, March 19, 1884].

If from the equation of any unicursal curve

$$x_1 : x_2 : x_3 = f_1(\lambda, 1) : f_2(\lambda, 1) : f_3(\lambda, 1),$$

we attempt to find an expression for λ we shall find that it takes the form

$$\lambda = \frac{\phi_1(x_1 x_2 x_3)}{\phi_2(x_1 x_2 x_3)},$$

where the ϕ's are rational homogeneous functions.

If the order of the unicursal curve u is n and that of the highest of the ϕ's m, then the curve $\varphi_1 - \lambda\varphi_2$, or ϕ intersects u in mn points; but as each value of λ determines but one point on u it must be that $mn - 1$ of these points are the same for all values of u and are among the intersections of ϕ_1 and φ_2.

If u has double points these must be among the fixed points and the two intersections at the double point will only count for one in the determination of φ.

We may say that one intersection has been absorbed by the double point. A triple point would absorb two intersections, an r-fold point $r - 1$ intersections, but we shall assume that in general a unicursal has no multiple points of higher order than the second, an assumption which we shall see to be perfectly justifiable. If then a curve is unicursal it is always possible to pass curves through all its double points and have the curves determined, but no more than determined by their intersections with the unicursal curve.

Suppose u has $\frac{n-1\,.\,n-2}{2} - D$ double points, then we have

$$(1) \qquad mn - \frac{n-1\,.\,n-2}{2} + D = \frac{m\,.\,m+3}{2},$$

which says that the intersections of u and ϕ, less the number of intersections absorbed by the double points of u, is equal to the number of points needed to determine φ.

But further, ϕ must be of an order sufficiently high to pass through all these double points and yet not be completely determined, *i. e.*,

$$(2) \qquad \frac{n-1\,.\,n-2}{2} - D < \frac{m\,.\,m+3}{2}.$$

If we solve (1) for m we find

$$m = \frac{2n-3}{2} \pm \tfrac{1}{2}\sqrt{1+8D},$$

which shows that D cannot be negative and must be of the form $\frac{k\,.\,k+1}{2}$. This gives $m = n - 1 + k$ and $n - 2 - k$.

For the first value of m, k must be zero unless $n = 1$ or 2, since if a curve of the mth order intersect one of the nth order ($m \gtreqless n$) in $mn - \frac{n-1\,.\,n-2}{2}$ points, the remaining $\frac{n-1\,.\,n-2}{2}$ points of intersection are completely determined. And for the second value of m, k must also be zero, as the addition of (1) and (2) shows that $m > n - 3$.

If u break up it must do so in such a way as not to increase the number of double points. It cannot therefore break up all into curves of zero deficiency, (conics and right lines). All the curves into which it breaks up will be of order $\leqq m$, except in the one case where $m = n - 2$, and u breaks up into a curve of order $(n - 1)$ and a right line which would necessitate ϕ meeting the line in $n - 1 = m + 1$ points. Any such curve of order k being met by ϕ in $mk - \frac{k-1\,.\,k-2}{2}$ points will have all of its intersections with ϕ completely determined.

For instance, suppose that a curve of the 5th order breaks up into a conic and a cubic. A second cubic passing through the six intersections of the conic and cubic will meet the first cubic in three remaining points, any two of which determine the third; or a quartic passing through the six intersections of conic and cubic will meet the cubic in six additional points of which only five can be taken at random.

If u has multiple points of a higher order than the second, we can use the same construction if through each r-fold point of u we pass $\phi\, r - 1$ times. For in so doing it intersects $\phi\, r\,.\,r - 1$ times as it would in passing through $\frac{r\,.\,r-1}{2}$ double points on u, and upon ϕ are imposed

$$\frac{r-1\,.\,r-2}{2} + r - 1 = \frac{r\,.\,r-1}{2}$$

conditions, the same as would be imposed by passing through $\frac{r\,.\,r-1}{2}$ double points on u.

Other constructions are allowable however. Thus, if u has an $(n-1)$-fold point we may take for ϕ a line through the $(n-1)$-fold point and meeting the curve besides in one variable point. Again if u is of order $2n$ and has 3 n-fold points and one $(n-1)$-fold point or is of order $2n+1$ and has 3 n-fold points and one $(n+1)$-fold point, it will have zero deficiency, and we may take for ϕ a conic passing through these four multiple points and meeting u in yet one other point.

Again, we may if there are multiple points of higher order than the second always take for ϕ a curve of order $n - 3$ passing through one of these multiple points of order r, $r - 2$ times and through the rest $r - 1$ times. The simplest case of this is when we have a triple point and $\frac{n-1\,.\,n-2}{2} - 3$ double points.

An examination of curves to the 12th order inclusive showed these to be the only ways in which we could take ϕ for those curves and rendered it exceedingly probable that no other solution was possible for any plane curves whatsoever. The general proof would require us to show that.

Given $2 < m < n - 3$,

$$\Sigma(r\,.\,r-1) = n-1\,.\,n-2,$$

$$\Sigma(r-1) = nm - \frac{m\,.\,m+3}{2},$$

that then the number of r's $> \frac{m\,.\,m+3}{2} - 1$,

$$\text{or } \Sigma r > mn - 1.$$

It was noticed that when we came to curves of the 10th order certain arrangements of multiple points appeared which were plainly impossible, *e. g.*, a 7-fold and a 6-fold point would be equivalent to 36 double points, the number possible on the curve of 10th order, but a line through them would meet the curve in thirteen points.

Note on the foregoing paper. By G. BISSING.

It may be interesting to note that the theorem for n-fold space, analogous to that made the subject of Mr. Davis's communication, is "a unicursal curve of degree p in n-flat space has $\frac{1}{2}(p-1)(p-2)\,\overline{n-2}$ flats passing through $n-2$ fixed points on or off the curve and two variable points on it." In four-fold space for instance take all the planes through any two fixed points and two variable points on the curve, and take for one of the fixed points the point at infinity on the fourth co-ordinate axis. Then from this point at infinity project the curve, planes, &c., into three-fold space. The curve becomes a curve, the remaining fixed point a fixed point (the one from which we project being lost), and the planes become the lines through one fixed point and two variable points on the curve in which they actually cut the three-fold space. That is, every one of the singularities in question is projected into an apparent double point, and the converse is also true. It is furthermore evident that this same reasoning will hold in general. Since therefore a unicursal curve of degree p in three-fold space has $\frac{1}{2}(p-1)(p-2)$ apparent double points, the proposition is proved.

Note on Cycles. By A. S. HATHAWAY.

[Read before the University Mathematical Society at a meeting held March 19, 1884].

A cycle may be defined as an assemblage of terms such that if all the terms are multiplied by any given one, the assemblage remains unaltered, the terms being simply interchanged. Examples of cycles are: the four fourth roots of unity, $1, -1, \sqrt{-1}, -\sqrt{-1}$; the two sets of residues of 15, 1, 2, 4, 8, and 3, 6, 9, 12.

The existence of cycles depends upon the existence of repetents, or terms which multiplied by themselves remain unchanged. In the above examples, 1, 6, are the repetents. A cycle is composed simply of roots of repetents, *i. e.*, of terms which raised to certain powers become repetents; or else the cycle (which contains all the powers of any given term) contains an infinite number of different terms.

If a multiplier b leave one term a of a cycle $a, a', \ldots$ unaltered, it will leave every term unaltered. This is evident from the fact that the cycle may be written in the form $a.a, a.a', \ldots$ If the multiplier is a member of

the cycle, it is a repetent, for it leaves itself unaltered. A cycle cannot have two different repetents, since either of two repetents of a cycle is the same as their product. The same principle shows that every member is repeated exactly as many times as is the repetent.

The important feature regarding cycles, is that they possess a calculus. All possible products between two cycles form a cycle, and may be called the product of the cycles. Any cycle which is contained within a given cycle is in this sense a divisor of the given cycle; and its order is therefore a divisor of the order of the given cycle. A cycle may be factored corresponding to any factoring of its order; and can be resolved in only one way into factors corresponding to the relatively prime factors of its order.

The index of a cycle is the least power for which every member becomes a repetent, *i. e.*, the least common multiple of the indices of the several members. The index is a divisor of the order and contains all the prime divisors of the order.

There are many properties of cycles which can be much more readily developed from this calculus than in any other way.

Note on Lines of Curvature. By G. Bissing.

[Abstract of a paper read at the meeting of the University Mathematical Association, January 16, 1884.]

Letting x, y, z denote cartesian coordinates and u, v arbitrary parameters, the equations of the developable surface whose edge of regression is the space curve

$$x = f_1(u), \qquad y = f_2(u), \qquad z = f_3(u),$$

are

$$x = f_1(u) + vf'_1(u),$$
$$y = f_2(u) + vf'_2(u),$$
$$z = f_3(u) + vf'_3(u).$$

By integrating a simple differential equation the relation between u and v which gives the lines of curvature of this surface was shown to be

$$[f'_1(u)]^2 + [f'_2(u)]^2 + [f'_3(u)]^2 = ce^{-2(u+v)},$$

where c is the arbitrary constant.

PHILOLOGY AND ARCHÆOLOGY.

On K. Brugmann's recent Grammatical Studies. By C. D. Morris.

[Abstract of a paper read before the University Philological Association, May 2, 1884].

An account was given of some recent speculations of K. Brugmann on points of Greek grammar; first as to the use of πάρος, sans. *purā*, with the present to represent past time. It was shown that the present tense is essentially timeless; and that it was this timeless character which gave occasion to the employment of the form as the so-called historical present and also as a future, when a point of future time is sufficiently indicated by some other word in the sentence. The second question discussed was as to the existence in languages of the Aryan family of synthetic forms to express relative time; and the conclusion arrived at was that such forms exist only in the pluperfect and future perfect in Latin; being developed there as a consequence of the intrusion of the *s*-aorist into the sphere of the perfect.

The third point treated of was the existence in Greek of the two prepositions ἐν and εἰς, while the Romans contented themselves with a single *in* in both meanings. It was shown that εἰς represents a form ἐνς, which arose under the influence of ἐξ, the final sibilant of which, though originally having an ablative power, came gradually to lose its significance; and then the constant use in juxtaposition of the notions *into* and *out of* gave occasion to the assumption of a corresponding form by both prepositions; just as ἐκποδών (ἐκ ποδῶν) suggested ἐμποδών and *septentrionalis* occasioned *meridionalis*. The last and longest of the discussions was on the particle ἀρα. Its uses were clearly traced, and it was shown that the Lithuanian particle *ir* exhibits a remarkable correspondence with them. Brugmann acquiesces in the old connection of this particle with the root of ἀραρίσκω. It may be worth while to give here in outline the uses of ἀρα (*ir*) as they are developed in this paper, with a single reference for each. Ἀρα expresses

I. Coincidence or Correspondence.
  (*a*) in time, Z. 515: in place, A 149: in quality, A 158: in quantity, P. 266.
  (*b*) between charge and execution, between assertion and fact, B. 16.
  (*c*) between detailed statement and subsequent summary, T. 158.
  (*d*) between conclusion and premises, H. 360.
  (*e*) between cause and consequence, A. 56.

II. Immediate sequence or concatenation.
  (*a*) in time, B. 103.
  (*b*) in consequence, Θ 397.
  (*c*) merely in the conception of the speaker, the real order being indifferent, B. 621.

These last, however, run so closely together that it is not practicable to classify the examples with certainty.

A Study of Dinarchus. By E. G. Sihler.

[Abstract of a paper read before the University Philological Association, May 2, 1884].

Having glanced at some curious analogies in the rhetorical career of the first and the last of the ten Attic orators, and having noticed the neglect of Dinarchus even in the times antedating Dionysius, the author gave a brief sketch of the life of Dinarchus, mainly from Dionysius; for the data which are original in the *vita* (in X oratt. vitt.) are loose inferences. Stress was laid on the removal of Aeschines from Athens in consequence of the issue of Ctesiphon's trial,—whereby the most eminent competitor of Dinarchus was eliminated from the political and forensic field. It is curious, too, that after the Macedonian and oligarchic reconstruction of Athens in 322, Dinarchus did not obtain the franchise; Dinarchus' appearance against Demades, his friendship with Demetrius of Phalerum, and his subsequent banishment in the anti-Macedonian reaction of 307 B. C., justify us in making the inference that the politician in Dinarchus was well expressed, while he apparently (fragm. 86, Müller) was satisfied with the wealth and prestige gained by him in a purely professional capacity.

A number of the more elaborate *periods* of Dinarchus were syntactically analyzed and anacolutha were pointed out in several of them, the force of which observation goes far to vindicate the MSS. reading in two distinct passages (c. Dem. 5, ἡ βουλή—and c. Philoch. § 18 fin. where Maetzner and the Zurich editors assume a lacuna).

In σύνθεσις a conspectus was given of Dinarchus' use of hyperbaton and of the postponement and emphatic position of telling words and phrases in the Demosthenean vein, also of λέξις κατεστραμμένη, of ἀναδίπλωσις, and of δεινότης λέξεως, *i. e.* the choice of strong or strange expressions. In the range of vituperative epithets it was shown through a parallel with Aeschines that Dinarchus remained entirely within the limits of established tradition. Considerable skill was conceded to Dinarchus in his manipulation of *anaphora* in the frequency of which he goes beyond both Demosthenes and Aeschines. Finally it was shown that there is little originality in Dinarchus' choice of ideas and rhetorical argument.

The endeavor was made to give everywhere a tolerably exhaustive conspectus of passages illustrating the several points of rhetorical analysis. (This paper is the expansion of an essay prepared for the Johns Hopkins Philological Seminary, during the session of 1877–78).

Parallelism in Beowulf. By C. B. Wright.

[Abstract of a paper read before the University Philological Association, April 4, 1884].

The parallelistic feature of Anglo-Saxon verse is in no respect a growth; a perfected tendency is coexistent with the earliest poetic impulse and it permeates the poetic mass. In the Beowulf saga the phenomenon is as finished as it is frequent; at the close of the tenth century it is still finding vigorous expression in the story of Byrhtnoth's death. In the absence of adequate treatment of so marked a poetic factor, the paper seeks to indicate the parallelistic scope by a detailed examination in Beowulf of its first 500 verses.

Synonymous parallelism, in its various modifications, embraces a majority of the completed forms; a type is furnished by vv. 124–5:

. . . thanon eft gewât
hûðe hrêmig tô hâm faran,
mid thaere wäl-fylle wîca neósan.

Parallelistic antithesis is of comparatively rare occurrence, the Anglo-Saxon mind, uninfluenced by external usages, being but little in harmony with adversative forms. The present section contains but three genuine, antithetically balanced parallels, viz.: vv. 20–23, 109–10, 183–8. Throughout the body of Anglo-Saxon verse, a majority of these rare antitheses appear to be connected with the antithetical ideas involved in future reward and punishment; the exceptional occurrence of five examples in the first 75 verses of Genesis apparently results from the nature of the subject — the original glory of the fallen angels and their condemnation to the abodes of hell.

If (A) $\begin{cases} \text{SVM} \\ \text{SVM}' \end{cases}$ (subject, verb, modifier), be the normal form of a parallelistic couplet, it cannot be questioned that (B) $\begin{cases} \text{SVM} \\ \text{S(V)M}' \end{cases}$ involving the suppression in the second member of a verb synonymous with that contained in the first, is subjectively legitimate as well; *e. g.*, vv. 55–6:

. . . fäder ellor hwearf,
aldor of earde . . .

Disintegrating the second member still farther we enter the region of synonymous words and phrases. Two forms result, (C) $\begin{cases} \text{SVM} \\ \text{S(VM)} \end{cases}$ or $\begin{cases} \text{SVM} \\ \text{(SV)M}' \end{cases}$ according as the remnant of this mutilated second member is synonymous with the subject or with the modifier of the first; these two forms are shown respectively in vv. 349–50:

wäs his môd-sefa manegum gecŷðed,
wîg and wîs-dôm: . . .

and vv. 119–20:

. . . sorge ne cûðon,
won-sceaft wera.

We have clearly passed the limits of parallelistic form; have we passed the limits of parallelistic tendency? The formulated series, (C), (B), (A), is a uniformly progressive one; shall we go too far in assuming that its various factors, (C) as well as (A), are the outgrowth of a single predilection?

On the Dialectic Equivalence of *n* to *š* in Proto-Babylonian. By CARL F. LEHMANN.

[Abstract of a paper read before the Society for the Study of Shemitic Philology, March 24, 1884].

There are two cases in which the equivalence of *n* to *š* in Proto-Babylonian seems certain:

1. Sumerian *šar:* Akkadian *ner* (Assyrian *šarru*) "leader," "king." Also in: Sum. *šar-mal:* Akk. *ner-gal* "king," "ruler" (literally "being leader").

2. Sum. *a-šera:* Akk. *a-nera* "to lament" (probably a compound of *a* "water" and *še-ir* "to lament," "to sigh").

W. A. I. IV. 9, 32a *mun-gi-eš*, upon which the assumption of a third case (Sum. *geš*, Akk. *gen*) had been based is now differently explained by Dr. Hommel in *Die Semitischen Völker und Sprachen*, vol. I, page 511, line 3 ff.

This correspondence was first pointed out by Professor Haupt (see "*Der Keilinschriftliche Sintfluthbericht*," page 25, note 16 and the passages quoted there). It is unexplained as yet (cf. Hommel: "*Die Semitischen Völker und Sprachen*," vol. I, p. 289). The following suggestions may perhaps be found acceptable:

Traces of Rhotacism appear in Sumero-Akkadian, Akk. *šeš* and *šer* to sigh, *e-eš* and *e-ir*, Ass. *bakû*, to weep. (Haupt, *Keilschrifttexte I*, p. 36, Nos. 865, 866). If then *r* is assumed as an intermediate stage between *š* and *n*, the only difficulty, that remains, is that of arriving at *n* from *r*.

A certain relation between *n* and *r* must have been assumed by those who admit the interchange of these two liquids in consequence of dissimilation, as in Aramaic *tĕrên* for *tĕnên* (Hebr. *šĕnayim*), Lithuanian *Mangarytà* for *Margarytà*.

Moreover there is no organic difficulty in the formation of a nasal *r*.—In Proto-Babylonian a phonetical correspondence of *n* to *r* can be shown: The word for "plantation," "garden" is *gan* as well as *kar;* both appear in Assyrian as *ginâ* and *kirî* respectively.

Furthermore, the Assyrians pronounced the name of the city, called *Erech* in the Old Testament, *Uruk*. In Akkadian its name is, as a rule, written ideographically, phonetically only once: *u-nu-ug* = *Unug*. Variations in the Akkadian pronunciation of this word cannot, therefore, be directly traced. It is highly probable, however, that in parts of ancient Babylonia the pronounciation was really *Urug*, whence the Assyrian form is derived. (See A. S. K. T. 1, p. 19, Nos. 330, 331, and compare especially 334.)

There is nothing, then, to prevent the conclusion that a nasal *r* forms the intermediate stage between *š* and *n*.

As variations do not occur in the two dialects alone, but also within each one of them (cf. Akkadian *ner* and *šiš* in comparison with Sumerian *šer* in *a-šera*), we possibly have to do with original coëxistence, and not with the development of one form out of the other.

The two words discussed here, show the correspondence of *n* to *š* in the beginning of a syllable and end in *r*. Dissimilation may therefore be the reason of the non-appearance of the intermediate form with *r*.

Rhythmical Pronunciation of Greek and Latin Prose and a few remarks on Accent. By C. W. E. MILLER.

[Abstract of a paper read before the University Philological Association, April 4, 1884].

By the rhythmical pronunciation of *any* language is meant its pronunciation as regards the *ictus* (stress) or *ictuses* of its words, when pronounced alone or in combination with other words. It is called *rhythmical* because on it *rhythm* in versification depends. This paper endeavors to point out the principal features of the correct rhythmical pronunciation of Greek prose, and to give some suggestions in regard to that of Latin; a few remarks on accent are added.

We postulate the principle that the versification of a language must be in accordance with the nature of the language. This amounts to saying that ictus in verse must depend on the same principle as ictus in prose.

We consider:

I. *Greek.*—It follows from the above postulate that the Greeks were able to read their rhythms correctly without a knowledge of the scansion. If this is true, the Modern-Greek method and the English method of pronouncing the prose of classic Greek are absolutely wrong, since, when applied to verse, they will not, except in very rare cases, enable one to read a single line of poetry without violating the rhythm.

The question now arises as to how we are to get at the correct pronunciation of classic Greek prose. We have seen above that ictus in verse is governed by the same principle as ictus in prose. Hence, if we know the principle that governs ictus in verse, we know that which governs ictus in prose. Now the fundamental law of Greek rhythm was found upon investigation to be the following: *A long syllable either preceding or following a single short syllable or two (not more) short syllables, must have the ictus.* This rule has no real exception in the ordinary rhythms, the only violation of it, occurring in the highly artistic form of the Dochmiac: >[⏑]⏑—[>]|—∧. Here the first long is followed by two shorts and ought to have the ictus, which it would certainly have in prose. To the other parts of the rule, no exceptions are known to us. This fact seems to be a corroboration of the statement that Greek is an iambic language. It may account for the absence of the following four forms of the dochmiac:

⏑ | — ⏑ ⏑ > | — ∧
> | — ⏑ ⏑ > | — ∧
⏑ | — ⏑ ⏑ > | ⏑ ⏑ ∧
> | — ⏑ ⏑ > | ⏑ ⏑ ∧.

The following law, depending upon the one given above, embraces the theory of the irrational long:

An ictus-lacking long syllable either preceding or following an ictus-bearing long is irrational.

These two laws may be summed up in the following general law:

A long syllable either preceding or following a single short, an irrational long, or two (not more) short syllables, must have the ictus.

Apply these rules in the pronunciation of Greek prose and you will approach very closely the rhythmical pronunciation of the ancient Greeks.

II. *Latin.*—In the case of Latin, it is still an open question whether the system of versification embodied in the large mass of their poetry is indigenous or merely an imitation of the Greek. All indications seem to point to the former. The versification of Plautus and Terence is so very distinct from the Greek that it is very difficult to see how it could be an imitation of it. Excepting, perhaps, that part of the fundamental law of Greek rhythm, which prescribes that a long followed by a single short must have the ictus, every other part is very frequently violated. To get an idea of the striking difference between Latin and Greek versification, one need but write out the scansion of fifty senarii of Plautus or Terence and compare them with fifty senarii of Aristophanes similarly written out. A marked characteristic of the Latin is the irrational Anapæst ⏑ ⏑ >. Another feature not to be overlooked is the remarkably frequent concurrence of word accent (pitch) and verse ictus (stress). This latter phenomenon would tend to show that in prose too, the concurrence of word accent (pitch) and word ictus (stress) was very frequent. Upon the whole, it is probable that the Latin language represents a state of transition from what is commonly called a *quantitive* language to what is commonly but *incorrectly* called a *rhythmical* language.

The only way to get a satisfactory and the quickest possible solution of this difficult problem is for one competent person to investigate the whole field of Latin versification and not limit himself to a special study of the Saturnian Verse, or of Plautus, or Terence, or, in short, of any single author or single rhythm.

Remarks on Accent.—There are four factors which enter into the pronunciation of a syllable; viz., quality, quantity, stress, and pitch. Now, since accent is independent of quality, quantity, and stress, and since the Greek names of the accents show their connection with pitch, we have adopted the theory that was proposed years ago, that accent is pitch; but it is not a musical pitch, such as is produced by the voice in singing.

On Inchoative or N-Verbs in Gothic and other Germanic Dialects. By A. E. Egge.

[Abstract of a paper read before the University Philological Association, May 2, 1884].

This paper was an attempt to point out the fundamental difference in Gothic and Scandinavian between the inchoative verbs, and passive and neuter verbs, as well as a criticism of several inaccurate statements and mistakes in regard to the subject in various English and German text-books. Thus, on p. 336 of Morris and Skeat's Spec. of E. E., Pt. II, in a note to l. 179 of "The Bruce," the editors say: "The introduction of the letter *n* renders a verb intransitive in Moeso-Gothic, Swedish, &c. Thus we have Sw. *vaka*, to watch, *vakna*, to awake." This is inaccurate and misleading. The verb quoted, *vaka*, is itself intransitive, and the adding of an *n* can therefore not *make* it intransitive; but this *n* makes verbs *inchoative*, changing the meaning in the case of *vaka* and *vakna* from "to be awake" to "to become awake," and when used to form verbs from adjectives, it signifies the entering into the state or quality expressed by the adjective (cf. *kvitna*, *sjukna*). Another misleading statement is found in Skeat's Etymol. Dict., in the otherwise valuable note to the word *awaken*. Mr. Skeat says: "In this suffix [*i. e.* -nan], the first *n* is formative, and conspicuous in both Moeso-Gothic and Scandinavian, in which language it is used to render a verb *intransitive* or *reflexive*." Some examples were then given to show the difference between inchoative and passive verbs in Danish. Thus the inchoative *vaagne* can only be used when no agent is expressed, or when the instrument or cause is a dead thing or a force (*aliqua re*), while the passive *väkkes* may be used either with a person (*ab aliquo*) or thing (*aliqua re*) as the logical subject. Thus I may say either *jeg väkkes* or *vaagner of stormen, of tordenen*, but only *jeg väkkes of min broder*, not *jeg vaagnede of min broder!* This is a pervading principle in the Scandinavian languages, and it applies equally well to Gothic, which is exceptionally rich in *n*-verbs. W. Braune's statement (on p. 75 of his Goth. Gram.) is therefore unsatisfactory, as it does not indicate clearly enough which are the more truly passive, the *n*-verbs or transitive verbs in the medio-passive voice. The false definitions of *gadauthnan* by Braune (p. 75) as = "to be killed," and of *gawaknan* by Skeat (Moeso-Goth. Gram. and Glos., and Spec. of E. E., Pt. II. under *valknyt* and *wake*) as = "to be awake" were referred to and corrected.

A full list of all Gothic nan-verbs was presented, together with references to the places where each occurs, and parallel forms from Old and Modern Norse. The great majority of them (about ⅔) are inchoative, while the few others are simple neuter verbs, at least as regards the examples in which they occur. In regard to *infeinan* and *uskeinan*, which by J. Grimm and others are classed with the inchoatives, the fact was pointed out that in every inchoative verb in Gothic (with the single exception of *gakwiunan*) and Scandinavian, there is a consonant before the *n*, which, besides what W. Braune states (p. 75, n. 2 of his Goth. Gram.), might be regarded as an additional reason for not referring these verbs to the class of inchoatives. *Fraihnan* and *maurnan* (A. S. *frignan*, *meornan*) were thought not to belong here because they form their pret. and p. p. as strong verbs, while all genuine inchoative verbs are weak.

In regard to the note by Gabelentz and Löbe (II², p. 138, 3, n. 1) where they say: "Oft kommt das Passivum neben diesen Wörtern dritter Conjugation von demselben Stamm vor, ohne dass ein wesentlicher Unterschied nachgeweisen werden könnte," etc., and adduce several examples to prove their theory, the belief was expressed that in each case a distinct difference must have been felt by the Gothic language-user, and in regard to most of the examples quoted in the note referred to, an attempt was made to show what this difference is. Thus, to take one example, it is quite easy to feel the difference in meaning between the two verbs in *Christus mêrjada* (1 Cor. 15, 12), "Christ is preached," and *usmêrnôda thata waurd bi ina* (Luc. 5, 15), "the fame of him went abroad" (the Greek in the first sentence has κηρύσσεται, in the second διήρχετο). If the last sentence had been "the fame of him was noised abroad by the people," the Gothic could not have been *usmêrnôda thata waurd bi ina fram thizai thiudai* but the passive of *usmêrjan* would have been used.

A list of Norwegian *n*-verbs was given together with a brief statement of the formation and use of *n*-verbs in the Scandinavian languages. In regard to Anglo Saxon the statement was made that it must also once have had a distinct class of verbs of this kind; but the introduction of an *i* or *j* after the *n*, making them look like verbs in *-jan* or *-njan*, where *j* and not *n* is the formative element (cf. *äfnian*, *beacnian*, etc.) seems by analogy to have brought about a corruption of meaning as well, rendering most of them transitive. Here we find perhaps also the explanation of the fact that in mod. Eng. all verbs in *-en*, whether lineal descendants of old inchoative verbs or new formations made on the analogy of these, are one and all factitive. A list of inchoative verbs in Anglo-Saxon and Early English was given, together with a number of references to places were they occur.

The name "inchoative," which is used only by Wimmer (Altnordische Gram., übersetzt v. E. Sievers, p. 127 top), was regarded as a better name for n-verbs than either "intransitive" or "passive," used by other authors, as it is evident that the majority of the verbs in question are strictly speaking neither, but answer in meaning very closely to the inchoative verbs in Latin and might with the same right as these be called inchoative.

The City of Harran: Notes on its Name and History. By C. Adler.

[Abstract of a paper read before the Society for the Study of Shemitic Philology, December 13, 1883].

The Biblical Harran, Κάρραι, Carrae, a locality famed for the defeat of Crassus, has always been a place of peculiar interest. The early Hebrew lexicographers are silent about it. The more modern ones (Gesenius and Fürst) derive the name from חרר, "to scorch, to burn." But Harran is not a scorched, burnt place. The Biblical reference to wells, etc., the character of the place as a station for caravans, a market, or both, Pliny's description, and the reports of travellers like Chesney, serve to show that Harran was, at one time, one of the most flourishing cities of Asia. In a communication to the London Athenaeum (April 19, 1862), Sir Henry Rawlinson suggested that the name of the place was derived from the Assyrian word for road *harranu*, and based his argument on the well-known character of the place as a public highway. This has finally been adopted in the 9th edition of Gesenius (Mühlau & Volck) as a possible derivation. Harran is mentioned seven times in Genesis, in II Kings 19:12, do. 37:12 and Ez. 27:23; Ptolemy, Strabo, Chwolsohn, and Dean Stanley all practically agree as to its location. They place it in about latitude 36°, in Mesopotamia on the river Belik, identifying it with Greek Κάρραι. Dr. Beke, as early as 1834, doubted this, and from November, 1861 through to May, 1862, a controversy raged on the subject in the *Athenaeum*, Prof. Porter, Dr. Beke and

Sir Henry Rawlinson taking part. We can, however, conclude with Dean Stanley that this discussion left the question where he found it, and that no arguments have been advanced to cause us to abandon the above mentioned location of Harran.

A diligent search among early Jewish writers was not rewarded by the discovery of any traditions concerning the place. The Syriac Chronicle contains a legend that the city was founded by Arpahschad, the grandson of Noah. According to one of the Arabic Chronicles, Laban built the town. Yaqut asserts that it was the first place built after the flood. Judging from the Biblical account alone, we would conclude that Harran was a very ancient city. There Terah died. There Abraham stayed, and he came away with an increase of property and especially slaves, a circumstance that has led many to infer that Harran was a slave market. Jacob fled thither to Laban. After this we lose sight of it until the time of Hezekiah when it is taken by the Assyrians. Again it passes out of sight, though Chesney asserts, without giving his authority, that Alexander the Great passed through the town during his campaign in Asia, until we find it appearing in Roman history (Plutarch, Ammianus and Dio-Cassius) as the scene of the annihilation of the army of Crassus. Under the Empire we find that Caracalla was assassinated on the road from Edessa to Carrae, whither he was going to worship the moon-god. In more modern times the place is noted for its obstinate adherence to paganism. The Christians were few, and we find several of the Christian Bishops speaking of the people as a godless race. As late as the VIIIth century, according to Abu Jusuf el Qathi, it was customary to offer human sacrifices. The victim was generally a man of good reputation and handsome appearance, and after the sacrifice his head was cut off and used as an oracle. It is difficult to make any definite statements concerning the inhabitants of Harran. Chwolsohn and Sir Henry Rawlinson are inclined to think that it was inhabited by כסרים, an Arian or Iranian race, whom the former identifies with the Kurds. Rawlinson finds some difficulty in identifying the כסרים with the Χαλδαῖοι, though, as everyone knows now, the interchange between *s* and *l* is one of the commonest of the Assyrian phonetic laws.

Christian Mosaic-painting in Italy (IV to XIV Century).

By A. L. FROTHINGHAM, Jr.

[Abstract of a paper read before the University Archæological Society, May 9, 1884].

Mosaic-painting from its permanent and unchangeable character is one of the most valuable branches of Christian archæology. Of the three kinds used by the Romans—the *opus sectile*, *tessellatum* and *vermiculatum*—the latter only was used for wall-mosaics, which are here in question. This species was formed of minute cubes of marble, composition or glass paste, of innumerable shades. The artificially-made cubes came more and more into use after the fifth century. The artist himself made his cartoons, selected his cubes, drew his outlines on the wet mortar and then filled them in according to his colored design. Christian art very early made use of mosaics: numbers existed in the catacombs of Rome and Naples belonging to the fourth and fifth centuries. When Constantine caused magnificent basilicas to be built throughout the Empire, mosaic-painting, which unites perfectly with architecture, was employed almost exclusively for their decoration. The two great schools which then arose in Italy were those of Rome and Ravenna: both preserved much of the classical style down to the sixth century. In Rome this was combined with a strong naturalistic tendency, while in Ravenna there were two currents, the Latin and the Greek, the latter of which finally prevailed at the time of Justinian. Other schools of minor importance were at Naples, Capua, Milan, and Vercelli. The iconoclastic movement caused an influx of Greek artists to Rome, where among their scholars there arose an Italo-Byzantine style of mosaic-painting which became debased and died out in the ninth century.

After a blank of about two hundred years a revival of mosaic-painting took place in Italy: this was due to the importation of Greek artists, some of whom were established at Monte-Cassino (in 1066) and others at Venice. The Greek influence produced different effects according to the schools it affected: in Sicily the style was more oriental, in Rome more blended with classical reminiscences, in Venice more energetic and varied, yet predominantly Greek. At Rome the school of the so-called Cosmati marked a revival of the mosaic art, preceding the Tuscan, and produced works of great interest. The Tuscan school was derived from the Venetian and took a prominent part at the time of the great revival in painting at the close of the thirteenth century: the works of Jacobus Torriti in Rome and those in the Baptistery of Florence are worthy of admiration. Although such great artists as Cimabue, Duccio, Gaddo Gaddi and even Giotto were mosaicists, yet the new departure taken by Giotto gave such a preference to the more naturalistic form, fresco-painting, that mosaics rapidly fell into disuse, and the mosaicist, from being an artist, fell to the rank of a mere artisan to whom designs were furnished by painters of note. This kind of work flourished in Rome and Venice for several centuries.

BIOLOGY.

The Significance of the Larval Skin in Decapods.

By H. W. CONN.

[Abstract of a paper in the *Studies from the Biological Laboratory*, Vol. III, No. 1, March, 1884, with two plates].

The article contains a discussion of the phylogenetic significance of the peculiar structure enclosing the embryos of vertebrates known as the larval skin. This skin, being probably of no physiological importance, is, therefore, particularly valuable in its morphological significance. A number of new types of larval skin are described; (Callinectes Sesarma Pinnotheres): and it is shown that there is a complete and graduated series beginning with a form like Panopeus, where the larval skin is a highly complex structure with many feathered spines and ending on a form like Pinnotheres where the cuticle is nothing more than a larval covering with no spines. In general also it is found that the more complex larval skin is found in crabs, which stand low in classification, while the simple larval covering is found in more highly organized Brachyura; a condition of things just as we should expect from the consideration that this structure represents the ecdysis of some stage in the crab development earlier than the zoea. It is further shown that such an earlier stage was probably a protozea and that we, therefore, have here strong evidence that this stage was formerly included in the ontogeny and therefore in the phylogeny of the Brachuray. Finally, it is argued that evidence is here obtained tending very strongly to show that the Decapod zoea is simply a larval form which has never been represented in the phylogenetic history of the group, contrary to what has been claimed by Müller, and later in a different form by Balfour.

On the Life History of Thalassema. By H. W. CONN.

[Abstract of a paper in the *Studies from the Biological Laboratory*, Vol. III, No. 1, March, 1884, with one plate].

The article contains a brief account of the more important points embodied in a larger paper not yet published. They are as follows:

1. Origin of ova and spermatozoa as modified peritoneal cells, their growth in the body cavity as independent cells, and their preservation in a sexually mature condition in the sexual pouches.
2. Protrusion of two polar globules exhibiting a rhythm similar to that of the segmenting ova.
3. Segmentation, which is perfectly regular, forming an exception to Annelids in general.
4. Formation of gastrula by a typical invagination.
5. Early appearance of a preoral band of cilia, and its subsequent disappearance and replacement by a *row* of longer, more powerful cilia.
6. The transformation of the gastrula into the trochosphere by a peculiar method of growth.
7. Origin of mesoderm is two-fold and the segmentation of mesodermal bands.
8. Origin of ventral nerve chord from the ectoderm as a bilateral structure.

The Coagulation of Blood. By W. H. Howell.

[Abstract of a paper read at the meeting of the University Scientific Association, April 2, 1884].

According to the theory of Hammarsten the fibrin of coagulated blood is formed from the fibrinogen alone of the plasma under the influence of the fibrin ferment. While according to the older, and, at present, more generally accepted view of Schmidt, paraglobulin or fibrinoplastin is a necessary factor in the formation of fibrin.

Hammarsten's experiments were made upon the blood of mammals, and, so far as I know, have never been corroborated by any other investigator. A desire to test the correctness of Hammarsten's theory upon one of the lower animals led me to a series of experiments upon the blood of the terrapin, similar to those made by him upon the mammal. The blood was received directly into a glass cylinder packed in ice, and allowed to stand for one or two days. At the expiration of that time the corpuscles had settled to such an extent that a quantity of clear plasma equal to about two-thirds of the original bulk of blood could be siphoned off. This plasma was filtered, to free it from white corpuscles, and the fibrinogen then precipitated by the addition of an equal volume of a saturated solution of NaCl. The precipitate was filtered off, dissolved in dilute NaCl solution, and the process of precipitation repeated three times in all. The final precipitate was dissolved in distilled water, and gave a solution of fibrinogen which contained not a trace of paraglobulin. When an aqueous solution of ferment, prepared by Schmidt's method, and likewise entirely free from paraglobulin, was added to the fibrinogen a firm clot was obtained in all cases. The amount of fibrin formed from the fibrinogen under the action of a powerful ferment was, according to one experiment, 69 per cent.

The solution of fibrinogen was sometimes slightly opalescent, sometimes perfectly clear. When heated to 56° to 60° C. a complete coagulation occurred, the liquid when filtered from the finely granular precipitate and boiled, showed, usually, not the slightest opalescence. In some cases a very faint cloudiness was observed. The action of my fibrinogen solution differs markedly in this respect from that obtained by Hammarsten from the mammalian blood. According to him only a portion of the fibrinogen, 65 to 91 per cent., coagulates at this temperature, the remainder staying in solution as a new globulin, and coagulating at a temperature of from 64° to 65° C.

On the Molluscan Gill. By H. L. Osborn.

[Abstract of a paper read before the University Scientific Association, March 5, 1884].

Peck and Mitsukuri have elucidated the Lamellibranch gill and given reason for believing that it is not, primarily, the highly complex organ it is in most of the present Lamellibranch forms but that this complexity is secondary; that in its simplest form, as shown by its comparative anatomy in adults and by its embryology, the gill is to be considered as a row of successive folds of the inner wall of the mantle entirely free from one another.

Studies of the prosobranch show that we have here a form of gill which is almost precisely like that which we must consider primitive in the Lamellibranch. Fusus, Neverita, Littorina, Eurosalpinx, Segaretus, Crepidula are all very closely similar. Their gills consist of a row of plates which are folds of the inner wall of the mantle hanging down freely into the mantle cavity where they are bathed continually with water. Such a form of gill is the form almost universally present in a very large majority of the prosobranchs. Its larval history shows that it arises as a series of ridges in the mantle-wall which increases its surface and its later history is briefly, a direct growth into the very simple adult condition. The habits of the creatures, locomotive and aquatic, as we should suppose those of the earliest ancestors to have been would tend to preserve the gill in its primitive condition, while the sedentary habits of life which have been adopted by the Lamellibranchs indicate that we must expect in their organization to find many special adaptations. It is therefore thought that in this resemblance between the gills of the prosobranchs and the least specialized gill of the Lamellibranch we have additional ground for the view which has been suggested by Brooks and Lankester (Article "Mollusca" in Encyclopedia Britannica) in opposition to all text-book doctrine that the Lamellibranchs are not the ancestors of the gasteropods but are degraded forms that have originated from the gasteropod stock if not actually from any cephalous mollusk.

HISTORY AND POLITICAL SCIENCE.

Congressional Government. By Woodrow Wilson.

[Abstract of two papers read before the Seminary of Historical and Political Science, May 9 and 16, 1884].

These two papers constitute the first two essays of an extended study of Congressional as contrasted with Parliamentary government. In the first paper, which is introductory to the more special and technical chapters which follow it, those tendencies of constitutional construction, those precedents of actual governmental practice, those phases of national thought upon questions of administration, those conditions of society, and those indications of future development were brought together which have caused the original, ideal balances of the theory of the Constitution to give place in the actual conduct of the federal government to a constitutional system, which, much broader, even in principles, than the Constitution itself—though still resting firmly upon that Constitution as its foundation,—knows the federal government, not as a power coördinate with the State governments, but as a power greater than they, both actually and potentially, and Congress as supreme director of national policy, to the overshadowing of both the prerogatives of the Executive and the privileges of the Judiciary. Under such a system Congress is, of course, properly the central figure of constitutional study. To know its methods of procedure and its ways and means of overseeing and directing the course of affairs is to know the most essential machinery of our national government; and, in order to know these things, one must see Congress from the inside.

In the second paper this inside view of Congress was exhibited in a sketch of that device of organization whereby the House of Representatives divides its work, and its functions of deliberation, amongst more than forty Standing Committees to whom go, as of course, all bills introduced, from whom emanate all the propositions that are vouchsafed consideration or advanced to action, and in whose hands, consequently, are the direction of business and the control both of debate and of conclusion. The peculiarities of this plan of Committee government were emphasized by extended contrasts with that other system of government, called "parliamentary," in which the powers given the Committee of the House of Representatives are conferred upon ministers who are also the advisers of the Executives;—a system which may be said to be the prevailing governmental fashion of the world. Of this system the British House of Commons is, of course, the parent type, though for the purposes of this essay, and for the sake of more varied illustration, the French constitution was put by the side of the British as a leading example of that plan whereby the heads of the Executive departments are made the leaders of the legislative majority, *thereby* securing a government characterized by free debate and a well-defined party policy. Parliamentary government is direct party government, Congressional government, indirect; in the one, responsibility rests upon a compact ministry all of one party, in the other, upon a disintegrate ministry of Committees which are made up of members of both parties and all factions, and which, unlike the ministry of the other system, do not come into direct contact with the practical affairs of administration. In the one the best, the picked men, lead; in the other, all, the weakest as well as the best, have a hand in leading, every member of the House being a member of one or other of the Standing Committees. In Congressional government, moreover, the decisive contests of legislation take place in the privacy of Committee rooms, whilst under Parliamentary government those contests of necessity take place in public, upon the floor of the legislative body. Unlike, however, as these two systems are, they are kin in representing a common effort to set up some such "legislative commission" as J. S. Mill proposed, whereby a numerous assembly, itself radically unfit to make good laws, can get good laws made. We have more than forty such commissions; Great Britain, only one.

County Government in Virginia. By E. INGLE.

[Abstract of a paper read at a meeting of the University Historical and Political Science Association, April 18, 1884].

Notwithstanding instructions to governors for setting up different forms of government in the colony, no county was created before 1630. The unsettled condition of the public mind, the gathering together of people into "great families," after the Indian massacre, caused extensive powers to be granted to the commissioners, who combined in themselves military and civil jurisdiction. But in 1634 there were created eight shires which were to be governed as shires in England with lieutenants, elected sheriffs, sergeants, and bailiffs. That these counties as a rule were named from and embraced local settlements is a curious phase in our institutional history, for it was nothing more or less than towns growing into counties. Planting was originally along the rivers and was confined to a small area. As Indian panics became less frequent, people ventured forth beyond stockades, and gradually went away from the towns. New planters came in and settled at once in remote parts. Population thus became too scattered to be ruled by a few military leaders. The complications arising from new conditions,—the importation of servants, the introduction of negro slaves, and the settling of new land, necessitated a court and public functionaries to secure harmony. The wishes of the original settlers had great influence in the selection of the sites for court houses, so that in the older counties some inhabitants were often greatly inconvenienced by having to travel many miles to attend court. In the newer counties attempts were made to place the court houses as near the centre as possible; but as long as population remained in cis-montane regions, there was a tendency to seek the river banks for sites. The great point to be remembered is that, at first, counties were the outspreading of towns, not that towns, as later, were the aggregation of the people in a county seeking a place for the transaction of business. The rest of the paper was devoted to a study of the militia, county courts and their officers, and the other institutions of the county.

Samuel Adams, the Man of the Town-Meeting. By JAMES K. HOSMER.

[Abstract of a paper presented to the Seminary of Historical and Political Science April 4, 1884].

In New England, strong Celtic and, of late years, French Canadian elements have affected in many parts the character of the Town-Meeting. To study it, therefore, at its most characteristic stage, we must go back from the present. We must take it, too, at a time when the country had become in a measure developed. The intermediate epoch is that of the Revolution. Precisely then it is that we can, to most advantage, examine the American folk-mote. The town especially deserving of study is Boston. There the Town-meeting was most vigorous; the folk who carried it on were more numerous and intelligent than elsewhere; the events that flowed from its activity were the most momentous ever proceeding from such an origin. In the whole history of the Anglo-Saxon race, in fact, there have been no such interesting manifestations of the Folk-mote as in the Boston of the Revolution; from it came the independence of America. In the Revolution, Massachusetts led the thirteen colonies; Boston led Massachusetts. Who led the town of Boston? There are several conspicuous figures, men who through ability and character had influence in the town-meeting; but the controlling-mind was that of Samuel Adams. Others surpassed him in some kinds of ability, but no one was so admirable as a manager. His ascendency was marked; he was far-seeing and could combine men and arrange measures so as to secure great ends. He, first in the thirteen colonies, proposed a Congress looking toward a resistance to British encroachment, the Stamp Act Congress of 1764. Through his scheme of Committees of Correspondence the New England towns were combined. Though Virginia took the lead in the matter of intercolonial Committees of Correspondence, the incitements from New England had no doubt influenced her. First of Americans, Samuel Adams looked and labored for independence. Beyond all other men, he is "the type and representative of the Town-meeting." Though in various other positions of influence, the sphere he loved was the Town-meeting, there he accomplished his most memorable work, for that he was best fitted. In the democratic rule of the Town-meeting he thoroughly believed, carrying to an excess his dislike of delegated power.

E. A. Freeman remarks that in some of the American colonies "representation had supplanted the primitive Teutonic democracy which had sprung into life in the institutions of the first settlers." Over vast areas of our country at the present time representation has supplanted the primitive democracy. Yet in order that a representative system may be well managed, there ought to be, below all, the primary meeting of the individual citizens, discussing and deciding for themselves local affairs. It is too much, perhaps, to expect that the Folk-mote can be generally revived, but it is well to study the Town-meeting as it has been, and the figure so closely identified with it.

Sir George Calvert, Baron of Baltimore. By L. W. WILHELM.

[Abstract of a paper presented to the Historical Seminary, March meeting, 1884].

George Calvert, the founder of the Baltimore family of the Irish peerage, will find a permanent place in English history both as one of the chief councillors of James I., and as one of the pioneers in settling the English colonies in America. Although a strenuous advocate of the Spanish Match and a leader of the great Spanish party which was demoralized by the tactics of Buckingham, Calvert's claim to recognition has been almost ignored by English historians, but as the settler of the province of Avalon in Newfoundland and as the founder of Maryland, Calvert has preserved for himself enduring fame in the records of American colonial history. No complete biography of the famous colonizer has ever been written. Chapters only in his history have been sketched by Dr. John G. Morris, Prof. E. D. Neill, and the late Hon. John P. Kennedy. While one writer has thrown much light upon Calvert's economic schemes in America, another has devoted at least a third part of his admirable address to prove that Calvert was not converted from the church of England to the church of Rome.

The boyhood of Calvert is obscure. The date of his birth has not been accurately determined, although it was very probably about the year 1580. Born at Kiplin, near Richmond, Yorkshire, he lived, for some years previous to entering Oxford, at the neighboring town of Danby-wiske. The important landmarks in his career were his graduation from Trinity College, Oxford, in 1597, and his visit to the continent in the same year, his appointment to a clerkship under Secretary Cecil, 1603, and as clerk to the crown in 1606. His marriage had taken place in 1604 or 1605; in 1610 he revisited the continent; in 1611 he was appointed register of the garrisoned troops of Ireland and in 1613 was sent to Ireland on two very important commissions; in the same year he was appointed clerk to the Privy Council. He was knighted in 1617 and in 1619 he was made Secretary of State; he held this important office six years, resigning in March, 1625. Calvert's political and parliamentary career ran in parallel lines. In 1603 he was chosen to represent in parliament the borough of Bossinez; in 1621 he represented Yorkshire, and in 1625 the University of Oxford. He was created Baron of Baltimore by King James only a few weeks before the latter's death (March 27, 1625).

From the time of the disgrace of Lord Bacon (1621) to the final rout of the Spanish party (1625), Calvert's duties at Court and in Parliament were extremely arduous, important, and wearisome. As a friend to the Spanish ministers he was extremely obnoxious to Buckingham, and as a strong supporter of the King's prerogative he was thoroughly detested by such impetuous leaders of the Puritans in the House of Commons as Sandys, Philips and Coke. A broad-minded churchman, Calvert became very obnoxious to some of the more narrow-minded clergy. Archbishop Abbot spoke very bitterly about the Secretary, and denounced in caustic terms his conversion to Catholicism in 1625, the year in which he resigned the secretaryship.

Calvert became interested in trading companies very soon after his entrance upon his political career. In 1609 he became a stockholder of the East India Company and subsequently became a member of the London Company (South Virginia) and of the Plymouth Company (North Virginia or New England). Soon after his appointment to the secretaryship, Calvert became much interested in the Newfoundland settlements. He made the purchase of a large tract in the island (1620) and in the following year sent over a small colony

of fishermen and laborers. In 1622 he received a grant of the entire island of Newfoundland, but subsequently returned it for the peninsula of Avalon. In 1628 he decided to leave his home in Ireland and to make his permanent residence in Newfoundland, but the severity of the winter drove him to seek a dwelling place in a warmer climate. He reached the Virginia settlements in the autumn of 1629 and was charmed with the beauty of the country and with the hospitality of the people. His religious faith was an obstacle to his permanent residence among the Virginia Episcopalians and in 1630 he returned to England, where he remained until his death on April 15, 1632. Calvert endeavored to secure a grant of land in the territory lying south of the James River, but was thwarted by the opposition of the old Virginia Company.

In the grant of the province of Maryland he probably received the largest land grant in America ever received by a single individual from the English crown. As Sir George had died several months before the charter of Maryland had passed the great seal of England, the history of the settlement of Maryland and its early development belongs to the reign of his oldest son and heir, Cecilius, Lord Baltimore.

State and Local Taxation in Kentucky. By Arthur Yager.

[Abstract of a paper read before the Seminary of Historical and Political Science, April 25, 1884.]

The object of this paper was two-fold; first, to describe the present laws and machinery of taxation in Kentucky, in the light of the most recent developments of financial science; and secondly, to exhibit in their practical operation the local institutions of Kentucky and of the South as these reveal themselves in the administration of the local revenue. In spite of the abundant discussion of local taxation, which has taken place in the United States during the last decade, the field of investigation afforded by the Southern States seems to have been entirely neglected, and the consequent loss to our knowledge of the subject has been considerable. Although the laws, which formulate the state systems of taxation, are fundamentally the same in all the states, yet, owing to the radical difference in respect to institutions, officers, and local machinery, these laws produce very different results in the two great sections of the Union. The centralization of state organization in the South has in an extraordinary degree consolidated into the state-budgets all the most important and productive forms of taxation, while the stationary and uncommercial character of industrial life has reflected itself in the laws for the assessment of property.

In Kentucky about one-third of all the taxes in the state are levied and collected by the state government. In many rural districts the only kinds of property taxation known are those imposed by the state authorities. The unit of administration for financial, as well as other, purposes is the county. The chief financial officers of the county are the assessor and the sheriff, both being elected directly by the people. The assessor is elected for one year only, and is paid upon an average only about six hundred dollars per annum, the method of election, the tenure of office, and the amount of salary producing, as might be expected, great inefficiency in the conduct of the office. There is no state board of equalization, and the most glaring inequalities between different counties and classes of property naturally result.

As regards local taxation, all the ordinary expenses of county government are defrayed by the proceeds of the county levy—a simple poll-tax, imposed and regulated by the County Court. Property taxation for local purposes is not allowed, except in extraordinary cases and by special permission of the legislature. In the administration of the county levy, the sheriff is at the same time collector, treasurer and general controller. This officer presents many points of resemblance to his ancestor, the old English sheriff, both in respect to the multiplicity and vagueness of his powers, and as regards the laws enacted to restrain him. All cities and towns that provide for the maintenance of their own poor and the care of their own streets, are excused from paying their part of the county levy.

It will be seen that the fundamental defects in the financial machinery of Kentucky are inextricably bound up with the fundamental fact in state life, namely, the county, with its various institutions and officers. This same county organization, with all its defects, is the basis of political life all over the South, and with it are indissolubly connected many of the most important questions of public policy, including the educational question and the repudiation question.

LOGIC.

On the Syllogism. By J. Rendel Harris.

[Abstract of a paper read at a meeting of the University Metaphysical Club, April 22, 1884].

The following considerations will, I think, establish that all the valid Aristotelian syllogisms are modifications of a single one.

Let us remark in the first place that to every valid syllogism there belong a pair of related or conjugate syllogisms; for if P, Q, R be the premises and conclusion of a valid syllogism, and if P', Q', R', be respectively their direct contradictories, then $PR'Q'$ is a valid syllogism; for the conclusion cannot be Q, since in that case we could at once deduce R; it must there fore be Q'. And in the same way $QR'P'$ is a valid syllogism.

So far, I believe, we are following De Morgan; but I do not think it has been noticed that these three related syllogisms lie one in each of the first three figures or else they lie all in the fourth.

For example if PQR be in the first figure, which is denoted by

$$\left.\begin{array}{l} Y \ldots X \\ Z \ldots Y \\ \therefore\ Y \ldots X \end{array}\right\},$$

then when we form a syllogism in which the conclusion is the contradictory of the second member, we must make the syllogism take the form

$$\left.\begin{array}{l} Y \ldots X \\ Z \ldots X \\ \therefore\ Z \ldots Y \end{array}\right\},$$

which is the second figure; and so for the other syllogism.

We may then denote our three related syllogisms in the three figures as follows:

	Fig. 1.	Fig. 2.	Fig. 3.
	PQR	$PR'Q'$	$R'QP'$
or	$PR'Q'$	PRQ	$QR'P'$
or	$R'QP'$	$R'PQ'$	PQR ,

the two last being only different ways of writing the first.

In the fourth figure we have a syllogism PQR in the form

$$\left.\begin{array}{l} X \ldots Y \\ Y \ldots Z \\ \therefore\ Z \ldots X \end{array}\right\},$$

and the related syllogisms are evidently $R'PQ'$ and $QR'P'$ both of which are in the fourth figure also.

This establishes the conclusion that valid syllogisms come in three at a time.

But in the next place we observe that to every valid syllogism in each of the first three figures there belongs a conjugate syllogism in the same figure. From what has been said already it is only necessary to prove this for the second figure, since it must follow from this for the other two. Now if we consider a syllogism in the second figure

$$\left.\begin{array}{l} X \ldots Y \\ Z \ldots Y \\ \therefore\ Z \ldots X \end{array}\right\}$$

we observe that since Y does not appear in the conclusion it might have been replaced by anything else, which would disappear in the same manner. Let us then write *non-Y* for Y, or as we may say, introduce privative conception, which has the effect of interchanging A and E propositions, as also I and O. We have thus a new syllogism equally valid (for it is really identical) with the first, which we may call a contrary syllogism to it.

We have now established the conclusion that in the first three figures, valid syllogisms come in *six* at a time. From this we can at once deduce the whole of the common syllogisms.

For consider the following arrangement of syllogisms in each figure.

Fig. 1.		Fig. 2.		Fig. 3.	
AAA		*AOO*		*OAO*	
AII	*AAI*	*AEE*	*AEO*	*AII*	*AAI*
EAO	*EIO*	*EAO*	*EAE*	*EAO*	*EIO*
EAE		*EIO*		*IAI*	

Here the syllogisms placed at corresponding angles of the three figures are mutually dependent, forming a triad of valid or invalid syllogisms, while each syllogism in any figure has a conjugate one at the opposite angle of the hexagon in which it stands.

We now demonstrate as follows: assume, for instance, that *EIO* is valid in any figure, then since *E* and *I* may be simply converted, the syllogism is valid in all figures. And again if *EIO* is valid in any figure so must be *EAO* since *A* involves *I*. From these the figures at once show the whole eighteen syllogisms to be valid.

In the fourth figure the same supposition may be applied to the conjugate triads

FIG. 4.

AAI		*AEE*	
EAO	*AEO*	*EIO*	*IAI*

And the six syllogisms in this figure are at once proved. It appears therefore that any of the syllogisms may be made to prove all the rest, that the subaltern moods ought to be recognized in the syllogistic scheme; and that the fourth figure has a singular isolation from the other three.

The rejection of the invalid syllogisms according to this method is especially easy: for we have only one figure to examine of the first three. And if we take the second, we proceed as follows:

We cannot have two negative premises, and ∴ we cannot have two affirmative premises which are their contraries:

We can, therefore, have only one affirmative and one negative premiss; *i. e.* either

$$\left.\begin{matrix} AE \\ EA \end{matrix}\right\}, \text{ which give a valid conclusion.}$$

$$\left.\begin{matrix} AO \\ EI \end{matrix}\right\}, \text{ which also do so.}$$

There remain only the two pairs

$$\left.\begin{matrix} IE \\ OA \end{matrix}\right\}, \text{ and } \left.\begin{matrix} IO \\ OI \end{matrix}\right\},$$

of which if the first give no conclusion neither can the second which is contained in it. We have, therefore, only to demonstrate that *IEO* is an invalid syllogism in the second figure.

P. S.—Since reading the above paper I find that the relations of the separate moods and figures to which allusion has been made above were given by Mr. Peirce in a paper read before the American Academy of Arts and Sciences in 1867. J. R. H.

PETROGRAPHY.

Note on the so-called Quartz Porphyry at Hollins Station, north of Baltimore. By G. H. WILLIAMS.

[Abstract of a communication to the Naturalists' Field Club, April 30, 1884.]

In his first annual report, 1860, Philip Tyson, then State geologist of Maryland, mentioned an occurrence of quartz porphyry near the Relay Station on the Northern Central Railroad. This rock, which is admirably exposed in the cut just south of the present Hollins Station, does at first sight appear to correspond very well to Tyson's designation. It forms a band some three feet in thickness quite conformable to the bedding of the gneiss. To the unaided eye crystals of red feldspar and quartz appear to be porphyritically imbedded in a homogeneous grayish-green groundmass. Under the microscope, however, the rock is seen to possess an altogether fragmental character. Angular fragments of quartz, orthoclase, and plagioclase of all sizes and shapes are mingled with no regularity of arrangement, and are cemented together by secondary substances consisting mostly of silica, green hornblende needles and epidote. The occurrence of such a fragmental band interstratified with the highly crystalline gneisses, might possibly be accounted for by the supposition that it was originally a sedimentary bed, which had not been sufficiently metamorphosed to make a typical gneiss. To such an hypothesis, however, both the angular shape and the great variety in the size of the fragments is strongly opposed. Water must have sorted as well as rounded them.

It seems much more probable that this was originally a gneissic band, differing so far from the others in its constitution, that when subjected to the enormous pressure which raised the Appalachians, it was simply crushed—reduced to a more or less perfect powder, but held by the surrounding rocks in its position and subsequently re-cemented into a solid mass. The mineral constituents are identical with those of the gneiss, and all show, by their disturbed optical character, the action of great pressure. Moreover, the fragments have changed so little in their position that several lying near together may frequently be seen to have originally belonged to one crystal. Such crushed strata which have not been re-cemented are often met with in regions of great dislocation. Their occurrence in the Alps offered great hindrance to the completion of the St. Gothard tunnel.

RECENT APPOINTMENTS.

Professors and Teachers.

Dr. G. STANLEY HALL, late a Lecturer in Harvard University and Williams College, (as well as in Baltimore), has been appointed Professor of Psychology and Pedagogics.

Dr. W. H. WELCH, now Professor in the Bellevue Hospital Medical College (N. Y.), has been appointed Professor of Pathology in the medical department of this university. W. T. COUNCILMAN, M. D., has been chosen an Associate in Pathology.

Sir WILLIAM THOMSON, LL. D., Professor in the University of Glasgow, has accepted an invitation to deliver a course of lectures on Molecular Dynamics, during the month of October.

E. W. GOSSE, Esq., of London, Professor elect of English Literature, in the University of Cambridge, England, has been invited to deliver a course of lectures on English Literature.

PROFESSOR CORSON, of Cornell University, is also expected to deliver a course of lectures on English Literature.

Mr. A. M. ELLIOTT has been designated Associate Professor of the Romance Languages.

Mr. J. RENDEL HARRIS has been designated Associate Professor of New Testament Greek and Palaeography.

Mr. A. L. KIMBALL, Ph. D., a graduate of Princeton, has been designated an Associate in Physics, and Mr. C. A. PERKINS, Ph. D., a graduate of Williams, an Assistant in Physics.

Mr. W. H. HOWELL, Ph. D., has been appointed the chief Assistant in Biology.

Dr. HENRY WOOD has been transferred, by his own desire, from the chair of English to that of German.

Fellows.

The persons below named have been appointed Fellows for the academic year 1884–85 by the Trustees on the recommendation of the Academic Council.

ETHAN A. ANDREWS, of New York City, Ph. B., Yale College, 1881. *Biology.*

WILLIAM M. ARNOLT, of New Brunswick, N. J., B. D., New Brunswick Theological Seminary, 1882. *Greek.*

GUSTAV BISSING, of Baltimore, A. B., Johns Hopkins University, 1882. *Mathematics.*

HENRY CREW, of Wilmington, O., A. B., Princeton College, 1882. *Physics.*

JAMES R. DUGGAN, of Macon, Ga., A. B., Mercer University, 1877; M. D., Jefferson Medical College, 1879. *Chemistry.*

ARTHUR L. FROTHINGHAM, JR., of Rome, Italy, Ph. D., University of Leipsic, 1882. *Shemitic Languages.*

HOMER W. HILLYER, of Waupun, Wis., S. B., University of Wisconsin, 1882. *Chemistry.*

ABEL H. HUIZINGA, of Zeeland, Mich., A. B., Hope College, 1880. *Shemitic Languages.*

FREDERICK S. LEE, of Canton, N. Y., A. B., St. Lawrence University, 1878. *Biology.*

CHARLES H. LEVERMORE, of New Haven, Conn., A. B., Yale College, 1879. *History.*

GUSTAV A. LIEBIG, JR., of Baltimore, A. B., Johns Hopkins University, 1882. *Physics.*

C. W. EMIL MILLER, of Baltimore, A. B., Johns Hopkins University, 1882. *Greek.*

HENRY F. NACHTRIEB, of St. Paul, Minn., S. B., University of Minnesota, 1882. *Biology.*

HENRY B. NIXON, of Winfall, N. C., University of North Carolina, 1878. *Mathematics.*

ALBERT G. PALMER, of Baltimore, A. B., Johns Hopkins University, 1882. *Chemistry.*

ERNEST M. PEASE, of Boulder, Colorado, A. B., University of Colorado, 1882. *Latin.*

ALBERT H. TOLMAN, of Pittsfield, Mass., A. B., Williams College, 1877. *English.*

WOODROW WILSON, of Wilmington, N. C., A. B., Princeton College, 1879. *History.*

LECTURES ON CLASSICAL ARCHÆOLOGY.

During the past academic year special attention has been directed to the subject of Archæology and several lectures presenting the different phases of modern inquiry in that subject have been delivered before the students of this University.

An introductory lecture on "The Influence of Athletic Games on Greek Art," was delivered by Dr. CHARLES WALDSTEIN, Director of the Fitzwilliam Museum in the University of Cambridge. An abstract of this lecture is given on page 62 of *University Circular*, No. 29.

Mr. J. T. Clarke's Course on Assos, etc.

MR. JOSEPH THACHER CLARKE, who has been in charge of the excavations made by the Archæological Institute of America at Assos, Asia Minor, gave four lectures on March 10, 12, 14, and 17.

I. A PLEA FOR PRACTICAL ARCHÆOLOGY.

The first of these, a plea for practical research in this field, emphasized the fact that the great rise of archæology, during the past hundred years, to its present position as one of the sciences of exact determination, is mainly due to the development of its practical side: to investigations directly pursued in the lands ennobled by antique civilization.

The history of classical learning, during the past four centuries, has shown that, without frequent and systematic research among the material remains of earlier life, the real intercourse of modern generations with antiquity steadily declines. The want of archæological investigations during the ages succeeding the first great impulse of the Renaissance, and of that intelligent understanding only to be derived from discoveries thus made, resulted in the general stagnation and pedantic lifelessness of all classic learning which is so characteristic of the seventeenth century. The encouraging beginning of classical research made in the *Quattro-Cento* by Brunelleschi, Bracciolini, Squarcione, and notably by Cyriacus of Ancona, did not meet with encouragement sufficient to insure the position of archæological studies two hundred years later. During the seventeenth and the first half of the eighteenth centuries there was consequently no adequate understanding of the ill-arranged collections of antiquities as indices of former growth. The museums, while accumulating worthless curiosities and bric-à-brac of all kinds, dwindled in character to the discouraging cabinets of varieties which were the idle delight of every small potentate. A superficial knowledge of antique lore, and particularly of Latin versions of Greek mythology, was acquired to lend an ignoble grace to the masquerades of Louis Quatorze, and even as late as the time of Gesner, in the first years of the eighteenth century, these branches of learning were generally held in such low esteem that he,—the learned rector of the Thomas-Schule, Goettingen professor, and president of the academy of sciences,—seriously recommended a study of the classics to the *homines elegantes* of his day: that they might thereby be enabled rightly to comprehend the elaborate displays of fire works then in vogue, and dilate with learned emotions before the complicated and tasteless structures of white-of-egg and tinsel placed by the sugar-bakers upon the tables of the great.

The lamentable fate which befell so many of the Arundel marbles is a striking instance of the lack of general interest in archæological studies during this age: of the 250 inscribed stones which once formed part of that famous collection, only 136 ever reached Oxford, the remainder having entirely disappeared during the few years which elapsed between the acquisition of the antiques and their bequest to the university.

The spirit of the 16th and 17th centuries was foreign to the investigation of antiquity,—the age of Winckelmann did not first discover Pompeii, but was rather first prepared to understand the lessons taught by its ruins, and hence systematically to seek the treasures hidden by its debris.

Yet the wealth and interest of classic lands two hundred years ago may be judged from the fact that one explorer in the Archipelago returned to Europe with originals and copies of more than two thousand inscriptions. Cyriacus, Spon, even Stuart and Revett, saw and described monuments of antiquity which have now entirely disappeared. The Parthenon was practically intact when the earlier travellers visited Athens. The weathering of time, and above all the vandalism of man, steadily continue to deprive us of the material remnants of former civilizations. The rapidity of this destruction must be inconceivable to those not acquainted with the recent history of classic monuments from personal observation.

Let us not idly lament this inevitable destruction, but rather find in it the greatest stimulus to archæological research. The parable of the Sibylline books is brought forcibly to mind. Former investigators neglected points which we now seek with the greatest pains and prize as brilliant discoveries. We feel painfully that an unpublished monument overthrown, a work of art destroyed, is an irreparable loss: let us also bear in mind that future generations,—to whom even less will remain,—may justly hold us responsible for the opportunities we now neglect.

The lecture presented a review of the chief archæological explorations carried out since the pioneer work of Stuart and Revett, and illustrated the gradual growth of those exact methods of investigation which have given to the research of antiquity the certainty of comparative anatomy.

II. TWO LECTURES ON ASSOS.

The investigations carried on by the Archæological Institute of America at Assos, Asia Minor, give as perfect a picture of the life of a quiet provincial Greek capital, as the recent brilliant excavations at Olympia display the character of a great place of Hellenic festal assemblage.

Assos was a small town,—small even for antiquity, when cities were very far from the enormous dimensions of modern capitals. The number of its inhabitants can never have greatly exceeded twelve or fifteen thousand; but its interest and importance can by no means be judged by that of modern towns of equal size. Athens itself, at the time of its greatest extent and power, is known to have had only ten thousand houses, and twenty-one thousand free citizens, and this figure included the entirely separate harbor-cities of Munychia and the Piraeus. To take a more recent example: the imperial city of Augsburg, at the epoch of its chief historical fame, under Maximilian, had only sixteen thousand inhabitants,—was only about the same size as Assos.

The first report represented three months' excavation. There are now the results of two years of hard work to add to it; and these results have been fully proportionate. The first report was restricted, in the description of buildings examined, to the temple and the Greek bridge. To the knowledge of these structures so many additions have now been made, that the present restorations may be considered as perfect. The temple, already better known than any other building discovered in a similarly ruinous condition, appears as valuable an example for the history of Doric architecture as many which are standing to the top of the entablature. Several more of the reliefs carved upon its epistyle, the importance of which to the history of Greek sculpture is now recognized by all scholars, have been found since the publication of the report, and the entire stone ceiling of the building has been recovered. To this have been added many details, including most interesting and curiously suggestive observations concerning antique stone-cutting and laying.

Our knowledge of the geography of the lands has been further enriched by maps, geological as well as topographical. The story of its archæological recovery has been extended, while its political history has received most important additions.

The digging of the second and third years was mostly restricted to the lower town. Much work was done upon the fortifications of Assos, the finest known works of Greek military engineering. The oldest inhabitants settled close around the Acropolis, building rough walls of enormous blocks, not cut by any metallic tools, upon the levels just at the foot of the volcanic crater, and there did much terracing which was cleverly used by the later Greeks. The first outer circle wall was certainly old at the time of the Lydian invasion. Under the favoring influence of the Aeolic colonization, the city flourished greatly, and a new wall became necessary, which second masonry may have somewhat antedated the Persian wars. By reason of the troubles brought on by the Persian occupation of the land, the city decreased in extent, and when, under Lysimachos, its walls were rebuilt, the entire enclosure north of the Acropolis was relinquished. The ramparts, partially overthrown by sieges, were not considered worth repairing, and a connecting wall was built to the Acropolis in their stead. This noble mass of masonry of the fourth century B. C., rising in many places to some

sixty feet in height, was joined so accurately that the blade of a pen-knife cannot even now be introduced between the stones. It was this portion of the wall which caused Col. Leake to speak of Assos as the finest representative of a Greek city in existence. Under the dominion of the Romans the commercial city again increased, and finally re-occupied the space north of the Acropolis, new escarps being built in front of the walls, enclosing them entirely. The fortifications of Assos represent the work of more than a thousand years, the masonry in some parts, especially towards the eastern side of the city, closely resembling the ramparts of Constantinople.

The buildings of the Agora, or market-place, of Assos are so interesting and well-connected that they are superior to those of all other Greek cities; and, notwithstanding the elaborate works of the many writers who have investigated and described the market-place of Pompeii, we may even assert the Agora of Assos to be not only more interesting, but more completely known, than the forum of that city. The enormous Stoa, or Colonnade, one hundred and ten meters in length, was built, it may be with reason assumed, by the architect of the Stoa which surrounded the temple of Athena Polias at Pergamon, so recently excavated. It is constructed of the stone of the Acropolis, an andesite much resembling granite; a comparison between the forms given to this material and to the marble mouldings of Pergamon is most instructive. Being ceiled with wood, it needed only one support behind every second column of the front. Next to it, and apparently of the same date, is the bouleuterion, or building in which the archives of the city were kept. It is worthy of note, that most of the inscriptions found were in the slides of earth beneath this part of the Agora, evidently having been thrown down during the troubles of the city. The building is exactly parallel in character to the only other bouleuterion known—that in the Altis at Olympia; or rather, it is like the inner portion of that structure, there being at Olympia halls on either side of a centre like the edifice at Assos.

The building which borders the Agora on the south is absolutely unique. It is the only instance of a *Greek* bath known, and the only four-storied construction of antiquity ever recovered. Fortunately, we have beeen able perfectly to restore it. Its arrangement is extremely curious and interesting. It consisted of an enormous hall going through two stories, with twenty-six chambers upon its side; above this entire structure was a colonnade, the floor of which was upon the level of the agora. In front of the stoa was an enormous basin for the reception of water, covered by stone lintels and so paved that it was not visible to persons on the market-place. From it ran a subterranean conduit to the lower story of the bath, and there were arrangements for the water to flow into the thirteen lower cells. The refuse water was led into a larger basin beneath the bath building. There was another reservoir to receive the water from its roof; this connected with the street, and so formed an enormous fountain, giving pure water for the consumption of the people, while the water of the refuse basin adjoining it was used for the cooling of the theatre.

Next to the bath was built, in later times, a small heroön, in which the bodies of the benefactors of the city were deposited, their names being inscribed on the entablature. We opened the three sarcophagi standing in this building, which were found to contain only strigils, small vases, and the bones of the dead.

The changes of plan observable in the agora are peculiarly interesting. In early times there was an inclined plane ascending from a lower street to its level; but, when the heroön was intruded, the passage became so narrow that it had to be turned and transformed into a stairway. Two fine mosaics of comparatively early date were found just below the retaining wall of the market-place; the larger of these represented victories carrying votive offerings towards tripods, with a seller of cupids as centre piece; the other was bordered with geometrical figures, enclosing couching griffins,—the coat of arms of Assos. At the east of the agora was the bema, where the orator stood when addressing a crowd, the level of the place being there raised above the market-place and flagged, while the remainder, like all Greek streets before the Christian era, was unpaved.

Of the other buildings of the lower town, the theatre is now as well recovered as any building of its class in Asia Minor. Because of certain peculiarities of the stage, its recovery is particularly valuable for the history of the Greek theatre. The gymnasion, at the west of the town, is equal in preservation and interest to the gymnasion of Olympia,—the only one previously known. Noticeable also is a great atrium, of late date, but showing the preservation of Greek forms far into the Roman period,—the arch appearing with purely Hellenic details. In the lower town of Assos there were no less than seven Christian churches. The street of tombs is perhaps the most interesting burial-ground of the ancients hitherto investigated. It presents monuments of every period: one, notably, cannot be later than the seventh century B. C., and many are as recent as the eleventh or twelfth Christian centuries. In this necropolis are four great mausoleums, one of which presents a perfect parallel to the tombs of the kings at Jerusalem. We here opened one hundred and twenty-four sarcophagi for the first time, and found many cinerary urns, there having been at Assos a mixed system of inhumation and cremation. In the sarcophagi were discovered great numbers of figurini, small vases and glasses, among them some beautiful specimens of thin transparent glass, and several thousand coins.

An instance of the direct search made for materials bearing upon our knowledge of the development of various phases of ancient art may be seen in the fact, that two of the most interesting links that could be desired for Greek architectural history have been found by the expedition,—a proto-ionic capital, which stands between the ornamental spirals of Mesopotamia and the perfected ionic capitals of the Erechtheion; and a proto-doric shaft with a base, which prove with equal certainty the derivation of that column from an Egyptian shaft like that appearing in the tombs of Beni-Hassan.

The work at Assos labors under only one signal disadvantage: its results must be long awaited by those to whose munificence its execution is due.

III. CYRENE.

The Cyrenaica,—that blunt projecting headland some six hundred miles west of the Nile delta, to-day termed by physical geographers the great plateau of Barca,—was well-known to the earliest navigators of the Mediterranean, the Phoenicians and Carthaginians, both of whom appear to have richly profited by its extraordinary natural advantages. The state there founded by Greek colonists attained to an incomparable productivity and wealth during the most glorious period of Hellenic civilization,—was prized as one of the fairest African provinces by the Ptolemaic dynasties and the later Roman rulers — yet, wonderful to relate, this land was so entirely deserted and forgotten in the Middle Ages that for more than a thousand years its very existence was practically unknown to neighboring Europe.

A country which for twenty centuries had been one of the most flourishing states of the world,—a coast easily reached in forty-eight hours sail from Athens during the favorable northern winds prevalent in the summer season, and but little further removed from Italy,—had literally to be rediscovered during the lifetime of many still among us!

It is true that the bare fact of the existence of Greek and Roman remains in the Cyrenaica had been known some time before, but the accounts of the older travellers are so extremely meagre and unimportant that they merely heighten our wonder at the information given to the world by Beechey and by Pacho in 1827.

The first and the only excavations undertaken upon the site were those made by Captain Smith of the Royal Engineers and Commander Porcher of the British Navy. Their work, carried on with but very few men, was commenced in 1861, and completed in October of the same year. Yet the results of this short and ill-provided campaign were so fortunate that they may be said to occupy an exceptional position among similar undertakings. The volume published by the explorers makes mention of the discovery of no less than one hundred and forty-eight pieces of sculpture: some of these, full figures in a remarkably fine state of preservation, being works of first-rate importance. That the irregular work of a few months, carried on by naval officers untrained in scientific archæological research, should have been attended by such astonishingly favorable results is the greatest possible incentive to the undertaking of thorough investigations upon this once magnificent site.

The possibility of such rich discoveries is explained by the history of the ancient growth and overthrow of the city, and especially by the neglect which has since preserved the antique remains, in an almost deserted province.

Some of the most vexed questions of Archæology are likely to find their solution through investigations in the Cyrenaica. The influence of Egypt upon the early civilization of Greece can nowhere be displayed in greater directness than on this debatable ground. A knowledge of Cyrenian works cannot fail to give an incomparable insight into the development and independent advance of Hellenic forms.

Among all Greek cities there remains not one so accessible to the explorer as Cyrene; yet decisive changes in the government of Tripoli, and the consequent accessibility of the land, are imminent. Let us trust that this last remaining opportunity,—one offering exceptional advantages, may be vigorously followed up by our own country. We can never hope for a more favorable chance to make amends for a long and discreditable inactivity in the field of archæological research.

Mr. W. J. Stillman's Course of Lectures.

Mr. W. J. Stillman, late U. S. Consul at Crete, gave three lectures on March 19, 21, and 24.

I. Prehistoric Research in the Classical Field.

The first lecture was devoted to an account of the prehistoric ruins of Central and Southern Italy and Greece, commonly called Cyclopean or Pelasgic, which the lecturer classified and systematized, showing that the technical characteristics of this class of remains oblige us to connect them with a civilization independent of that of Asia Minor or Egypt, which he concluded to have been indigenous to Italy and to have been Pelasgic. As a parallel demonstration to that of the ruins, the lecturer collated the principal traditions about the Pelasgi, and elaborated the argument in favor of a fourth great independent civilization, those of Egypt, Mesopotamia, and China having been long admitted to be independent of each other. These Pelasgic ruins are of the stone epoch, ranging down to that of elaborately polished stone.

"I think it is impossible to avoid the conclusion that this entire series of constructions belongs to a civilization which had nothing whatever to do with that of the East, of Egypt, or of Mesopotamia, but which, on the contrary, had its origin and development in the circuit which I have traced, where it was the earliest of which we have any indication, and that where any wall occurs in that range containing brick, cut stone, or cement, it must be at once relegated to an epoch at least postheroic; I believe that this cycle closed by the entry into its realm of Eastern arts and knowledge consequent on the great ethnical movement typified possibly, or possibly ended, by the Trojan war. It met in Crete, in Asia Minor, and later in Greece, the Eastern movement, and the methods and knowledge of both are henceforth common property of the classical world.

"The more definite conclusion to which I am forced is that these remains were the work of a civilization which had its origin in Lower or Central Italy, and, moving southwards from a great centre in Etruria, made the seat of its highest power in the mountainous country of the Sabines, the cities about Alatri forming a large congeries of important states, or an empire relatively greater than any subsequent power in Italy until the Roman. The movement of this civilization or empire was down into Apulia, where are numerous remains of this polished stone period to which Alatri, Arpino, and Mykenae belong; then it reappears with unique distinctness at Kaphalu in Sicily, passes over to the Illyrian shores across the narrows of the Adriatic, extends only as far northwards as Dodona and Apollonia, but southwards founds a city or more on every one of the Illyrian Islands—Leukas (of Korkyra we can say nothing, as the Venetians had the habit of destroying all antique remains to construct their fortresses when more convenient than quarrying, and of Zante we know similarly of no remains); Kephallenia four or five; Ithaca two—and all along the main coast, then appearing in great force through the Peloponessus, in Kythera, Anti-Kythera, in Crete especially; and at various points following the northerly receding coast of Attica, and in Thessaly. But while this peculiar construction appears in the vicinity of Smyrna and in the Troad there is no trace of it in Phoenicia, Egypt, or any of the northern coasts of Africa."

II. The State of Research in Greece.

The second lecture, following the development of Hellenic art, showed the relations of the Pelasgic to the later epochs, and indicated the points from which, by the archæological indications, the most important information as to that development was to be hoped for, and followed the chief excavations of the last few years. It pointed out the important relation between the archæology of Athens and that of all the East, and showed the importance, under present political circumstances, which an American school of archæology at Athens might have in the development of that science, considering the mischief which the Greek archæological laws and jealousy of foreign governments had done, and which an American influence free from all political rivalries and animosities might help to remedy.

"The politics of Greece witness an amount of foreign interference which no other country in the world is obliged to submit to. Every diplomatic functionary of every European government considers himself authorized to interfere in the conduct of affairs, bully the ministers, stand between them and the king, dictate and veto as if Greece were really a province of his own country. The Greeks are abused for bad and unstable government when they have not even the shadow of administrative independence. The natural consequence is a refractoriness to foreign influence on the part of the best and most independent minds of the country which extends with a morbid irritability to every interest, even to archæological concessions.

"I believe that an American school properly endowed for real archæological work would be the most potent possible agency in the mollification of the Greek animosity to outsiders, and would be free to operate without any political jealousy, or suspicion of any attempt to acquire undue influence of any kind, and might well, being free from any suspicion of hidden purposes, approach the minds of all intelligent Greeks in a way which should lead to the desirable modification in their laws. To accomplish this would be meriting the laurel crown for our country. Apollo and the Muses invite us to receive their blessing in such a work."

III. The Relations of Art to Archæology.

The third lecture dealt with the relation of art to archæology and the division of art criticism into the archæological or scientific, and the æsthetic or sympathetic. To the former, Morelli's studies on the Italian school were recommended as a model and commencement; the German school of critics are in this branch preëminent, and we owe the proper method to their studies. In the æsthetic department the lecturer did not accept the German method or results, but looked to Burke as the founder of the true school of æsthetics, and Cousin, Ruskin, and the Platonists as following the line of investigation most likely to make æsthetics a scientific study.

He developed the homologies of the various forms of art, painting, music, etc.,—arguing that they all are governed by definite laws, the development of which proves that art is not imitation of nature but the expression of individuality and human emotion, its primary law being that of harmony and not resemblance. This was shown by a study of the growth and decline of the various epochs of art production, which invariably began to deteriorate when portraiture was reached.

Dr. A. Emerson's Lectures on Olympia, etc.

Dr. A. Emerson, Fellow in Greek, gave six lectures on Olympia, March 26–April 7, 1884.

I. The Olympic Festival.

A saying of Ernst Curtius: "The wreath is the armorial bearing of Greece," is borne out in the history of the Hellenic people, which is a continuous race of the Greek cities and tribes for the prize of excellence. In public and private life, the desire and delight of surpassing others is the key-note of the Greek character. Formal contests for a set prize, a preëminently Greek institution, concentrated effort in every department of activity, and thus deeply influenced the physical, intellectual, and moral development of the Greek race. Feasts and funerals were the occasions of athletic games in the heroic age; afterward these became fixed institutions of periodical recurrence. Many such celebrations originated in funeral rites; all were associated with the worship of the gods. Among a hundred, but few attained to a more than local importance; only four, the games celebrated quadrennially at Olympia, Delphoi, Nemea, and the Isthmos, were considered Panhellenic or national. The endeavor to elevate the Panathenaia to the same rank failed. Elsewhere, prizes of value, jars of oil at Athens, a silver cup at Marathon, etc., or even money, could be won; the prize of the national contests was the purely symbolical wreath. Greeks and barbarians recognized the elevating moral effect of so high an appreciation of excellence. The Olympic games were earliest established, greatest in renown, and longest celebrated. Their origin dates from mythic times. Conflicting legends indicate that many Doric and Achaian peoples had a share in their establishment. In the ninth century, Iphitos of Elis established a truce, by which the celebration of the games in time of war became possible, obtained the protection of Doric states for the neutrality of Elis by introducing there the cult of Herakles, and abolished the giving of material prizes, thus laying the foundations of Olympia's greatness. The document of the sacred truce (*ἐκεχειρία*), graven in ancient lettering upon a round stone afterward preserved at Olympia, is the earliest authentic Greek inscription of which we have record, and proves these events historical.

In 776 B. C. the registration of the victors so important for Grecian chronology was begun. The victor in the foot-race, a dash of 600 Olympic feet (192.27 m.), gave his name to the Olympiad. Under the pious pretext, at first, of restoring the practices of the heroic age, other athletic contests, and horse-races, were introduced from time to time, until the wreaths distributed numbered seventeen or more. The fashion and conditions of these contests were explained in detail and illustrated with diagrams from ancient sculptures and paintings. Uniform training, early registration, and fair play were required of the athletes, under penalty of exclusion, or, if fraud was discovered too late, of heavy fines. After the 15th Olympiad, the contestants entered the lists naked. Ancient and modern records were compared:

Day's run: Good Greek record, 150 km.;
Good modern record, 168 km.
Long running jump: Best Greek record, 55 feet;
Best modern record, 49 feet (Engl.) 8 inches.

As the victors in the horse-races were the registered owners of the animals, such victories could be and often were won by women. The course of a celebration in the time of Olympia's greatest prime was then narrated. The sacred month, Apollonios or Parthenios alternately, and with it abstention of all Greek soldiery in all Greek lands from molestation of persons journeying to the games, began with the first or second new moon after the summer solstice and was announced by Eleian heralds. The festival occupied five days from the 11th to the 15th of the month. The spectators found the athletes with their trainers, and the managers of the games, already on the ground. The multitude encamped around the Altis. Girls were permitted to see the games, but married women were excluded from the sanctuary for the five days of the festival, upon pain of death, and took up their abode on the other side of the Alpheios. The first day was devoted to the swearing-in and lot-drawing of the contestants and to public sacrifices. The processions of delegations from the Greek states were the chief feature of interest. The second day witnessed the contests of the boys. The central day decided the victory in the principal contest, the Stadion dash, and in the other foot-races of the men. Beginning at sunrise with the Dolichos, the sports were concluded at evening with the Pankration. On the fourth day the spectators saw the driven and ridden horse-races in the Hippodromos. The splendid spectacle of the four-abreast chariot-race made this day equal the third in interest. In the afternoon, the spectators returned to the Stadion to see the long-drawn-out contest of jumping, quoit and javelin throwing, running and wrestling, which constituted the Pentathlon. The presence, among the throng of spectators, of eminent Greek statesmen, warriors, philosophers, orators, and poets, contributed to the interest of the festival. The last day, when the distribution of the wreaths was over, afforded opportunity for the production of the odes written for the victors by such poets as Pindar or Simonides, and for the orations of a Gorgias and a Lysias. The banquets of the victors, often given at lavish expense, and protracted far into the night, concluded the festival. Still greater display could be made on the return of the victor to his native city. Exainetos of Akragas passed through the breach in its walls escorted by three hundred span of milk-white steeds. Lakedaimonian victors fought nearest the Spartan king in battle. The Olympic wild-olive wreath could not have been held in greater esteem.

II. Topography of the vicinity of Olympia and History of the Locality to the Completion of the Excavations.

The people of Elis were the installed managers of the national festival, and the land and people on the one hand, the games on the other, mutually influenced each other. The other cantons of the Peloponnesos that gird Arkadia round about, are separated from each other and from the central canton by lofty mountain ranges. Between Arkadia and Elis there is no water-shed; the waters of Arkadian rivers flow from the mountainous interior of the peninsula through the spreading valleys of Elis to the western sea. Some ancient geographers, for this reason, considered the two one. It was the neutrality attendant upon the curatorship of the games that preserved to Elis its early independence. A flat, marshy shore, with poor anchorages, turned the minds of the inhabitants from trade, and the insect pests of the lowlands kept them in the fertile interior hills and valleys, cattle-raising and farming. The Phoinikians and the sailor-folk of the neighboring Ionian islands had the trade to themselves. The Eleians lived, for the most part, on their paternal acres, in profound peace, and satisfied with an oligarchical government. Travelling justices and village fairs made it unnecessary for the country people to frequent the city. Polybius (iv, 73) tells of families none of whose members had for generations left their inherited lands for the city. Cotton was grown here alone in Greece, and woven into costly fabrics. Populous and law-abiding to a remarkable degree, Elis was withal a very religious country, "everywhere full of shrines of Artemis and Aphrodite and the nymphs, in groves abounding in flowers by reason of the moisture, and studded with chapels of Hermes along the roads and little sanctuaries of Poseidon on the coasts" (Strabo, p. 343). With less of prosperity, such is still the character of the region. The course of the Alpheios river and of its tributaries was described. The curious phenomena connected with the lake of Pheneos and the floods produced from time to time by its emptying itself into the Ladon were dwelt upon at length and it was shown that the deposits of earth over the site of Olympia are due to other causes. The five roads by which Olympia was anciently approached were traced on the map.

The history of the games was followed from their prime in the fifth century through the "colonial" fourth century to the decline of their Greek character by the admission of Romans and other barbarians, and through the increasing degradation of the Roman period to the victory of the Armenian Artavazd at the last celebration of the games in the 293d Olympiad, and Theodosius's prohibition of the games, A. D. 394. The Gothic hordes of Alaric invaded the Peloponnesos one year after this Christian prohibition of the pagan festival. They plundered, but did not destroy. In accordance with an edict of Theodosius II.; ordering the destruction of the remaining heathen sanctuaries, the temple of Zeus was fired A. D. 426. The final overthrow of the structure appears to be due to the great earthquake of July 9, A. D. 551, which buried 4000 people under the ruins of Naupaktos. Nothing more is heard of Olympia until modern times, when Montfaucon and Winckelmann were the first to advocate an excavation now happily consummated by the efforts of E. Curtius and the intelligent liberality of the German Diet, which voted $150,000 for the purpose.

III. The Description of Pausanias.

A Greek of the age of Hadrian and the Antonines has left us a description of Olympia in forty-two chapters, written in A. D. 174; these are in the books devoted to Elis of the Description of Greece by Pausanias, of Magnesia by the Sipylos. The writer and his manner were characterized. An antiquarian by predilection, he is very full on the older monuments of the Altis, but cares little for the later works, the most extensive and striking of which, the water-works and exedra of Herodes Atticus, he does not even mention. The most valuable parts of these chapters are those containing the minute descriptions of the ark of Kypselos in the Heraion and the statue of Zeus in the great temple. As making possible a mental reconstruction of this greatest work of Pheidias, the wonder of all antiquity, the latter description is of wider interest, and was entered upon in detail. The technical processes of statuary in gold and ivory were elucidated in accordance with the researches of Quatremère de Quincy, and illustrated by diagrams showing the processes of working ivory, and composing reliefs and statues out of pieces of ivory mechanically reproduced after the parts of a dissected plaster model.

IV. The Chief Architectural Monuments of the Altis.

Pausanias tells of a carefully protected wooden column shown him at Olympia, which tradition took for a part of the house of Oinomaos. In the Heraion he saw a similar monument of the primitive wood architecture of the Hellenes, the authenticity of which is now proved beyond a doubt by the curious features in the architectural remains of the Heraion. 1096 B. C. is the date tradition assigns for the building, and that may be the date of erection of the first temple on this site. It is not possible to assign a date for the temple of which the ruins exist, as it was not built at one time. A very elongated brick cella is surrounded by Doric columns placed so wide apart that a wooden entablature must be inferred—and no fragments of an entablature were discovered. There is no uniformity in the diameter, the fluting, or the capitals of the columns, whence it appears that they were inserted one by one as the older wooden pillars rotted and weakened. The wood derivation of the Doric style is thereby established. The inner portico was an addition not contemplated in the original plan, of which it preserved the alcove arrangement of the side walls, comparable to that of the temple of

Bassai. The terra cotta tiling and roof-decoration, which can be reconstructed from the pieces found, was archaic and elaborate. The building of the temple of Zeus occupied some fifteen years from the 77th to the 80th Olympiad, not, as was formerly supposed, 120 years. The booty made by the Eleians in subjugating a revolt of the Pisatis furnished the means for its erection by Libon, an Eleian architect. It is built of porous limestone, in the best style of Doric art, as a peripteral hexastyle of normal proportions (length, top of stylobate 64, 10 m. = 200 Olympic feet; width 27.72 m; height, inclusive of akroterion, 68 Olympic feet). Of other edifices of Olympia, the Buleuterion, in which the Eleian Council met during the festal month, is the most interesting. It was situated without the Altis, and is a unique example of Greek civic architecture. The ruined state and restorations of these and other buildings, with their details, were shown by means of the stereopticon.

V. The Sculptures of the Temple of Zeus.

The stereobate, walls, and columns of the temple must have stood completed at the opening of the seventy-ninth Olympiad. By this time the amount of sculptural work to be employed in the decoration of the temple had to be determined, and the execution of it confided to the artists whose services could be secured. Technical and practical considerations forbade the thought of adding the sculpture after the constructive portions of the architecture were in place. It is known that at Phigaleia, not far from Olympia, artists as distinguished as Onatas and Iktinos were hampered by dictation on the part of an ultra-conservative priesthood. At Olympia, where the progress of Greek art had, as it were, its living record, meddling with an artist's design on the part of the Elcian commissioners was not to be expected. But subjects and treatment, if the artists took their task seriously, had to indicate an agonistic sanctuary, with a local story and a Panhellenic significance, dedicated to the supreme Zeus. Nor was this enough, if harmony and artistic unity were not preserved. These last postulates required that all, workmen or artists, who worked at the sculptural decoration should be made subordinate to one head. Pheidias, to whom this position was given at Athens, did not come from Attica to Elis till the 83d Olympiad. Pausanias tells us that Paionios of Mende was the author of the Eastern pediment-group; the less conspicuous Western pediment was filled by Alkamenes. The inscription of Paionios on the base of the great marble Victory executed by him for the Messenians boastfully records that in a formal competition the prize was awarded to his *finials for the temple*: "*καὶ τἀκρωτήρια ποιῶν ἐπὶ τὸν ναὸν ἐνίκα.*" The finials of the temple were the statuettes of Victory that topped the pediments and the cauldrons surmounting the four corners, works of gilded bronze. Regarding these pieces as of small account, compared with the great statuary group of the pediment, eminent German archæologists have translated *ἀκρωτήρια* by "statues of the pediment," thereby unwarrantably wresting the word from its technical significance. The lecturer saw in this competition and victory a trial of skill, the outcome of which was the placing of the approved master in the position of chief director of all the sculptural work about the temple. It was fitting that this responsibility and honor should be vested in the artist whose design for these very conspicuous, though small, pieces, which were to crown the finished temple, showed the truest feeling for the spirit of the place and the keenest appreciation of architectural effect; fitting that the artist should be proud of what was the beginning and marked the end of his work on the temple. The spirit of the *agon* in formative art breaks out in its best periods. It is known of Alkamenes, on this occasion surpassed by Paionios, that he afterward grew to compete with Pheidias. The best test is not necessarily a design for the intended work itself. Ghiberti's relief of the Sacrifice of Isaac, now seen with Brunelleschi's in the Bargello at Florence, proved him a better man than Brunelleschi or della Quercia to trust with the execution of the great bronze doors of the Florentine Baptistery, a work of fifty years. The lions' heads of the cornice are merely architectural ornament; those preserved show, in a striking manner, the different degrees of ability represented among the commoner workmen. The sculptural decoration conformed to the character of the temple according to an evident system and plan. In the twelve metopae of the cella fronts, so disposed as to meet the eyes of the visitor in their due order, the contests and victories of Herakles, the son of Zeus, were represented, possibly by Paionios' Northern and Eleian assistants. The subject of the Eastern pediment group Paionios took from the local legend of Olympia; Pelops and Oinomaos, with their retinues, were seen preparing for their oft-sung chariot-race. The figure of Zeus, in the centre of the pediment, showed him sharing in and controlling the affairs of men. In the Western pediment, Alkamenes had rendered in marble the combat of the Centaurs and the Lapithai, the favorite subject of the Greek chisel because it celebrated the contest of law and order against ruthless and forbidden forces, the triumph of the athletic Greek over the uncouth monstrosity of the Barbarian. Apollon, the first Olympic victor, stood in the centre, turning the scales of battle in favor of the Greeks. Prayer and thanks for divine favor, in Greek form sacrifice to Zeus, the giver of all victory and success, was the thought embodied in the acroteria. The sculptures themselves, studied from the photographs of the originals and the model restorations by Grüttner, revealed an essential unity of style throughout, due partly, perhaps, to the commanding position of the principal artist, but in even greater measure to the northern Greek nativity of the sculptors. Mende, the birthplace of Paionios, and Lemnos, that of Alkamenes, were both in the pale of the pictorial Thessalo-Thracian school of art which deeply influenced Athens itself through Polygnotos of Thasos. Again, different pieces and parts, both of the metopae and of the pediment statues, display dissimilarities and inconsistencies such as cannot be due to the unequal skill of workmen: Olympia itself was a school and the traces of its influence are to be seen in certain Peloponnesian and Eleian affinities.

VI. Free Sculpture; the Victory of Paionios and the Hermes of Praxiteles.

Delving in the deeper strata of the Olympic soil brought many interesting relics of early art to light; among them are several specimens of primitive bronze work. A griffin's head, anciently the handle of a cauldron, and the beaten plate with a large relief of the winged Artemis holding two lions and a smaller one of Herakles pursuing a Centaur with human fore-legs, show early Greek figured bronzes to have been as Oriental in character as primitive bronze or terra-cotta ornament. The latter piece is of particular interest from the coincidence of the subjects with two that were carved upon the famous chest of Kypselos of Corinth, anciently preserved in the Heraion.

Two stone heads of Hera, the larger one probably that of the temple-image, compared with a small bronze Zeus of very archaic type, show a great superiority of early work in bronze over contemporary sculpture.

The monument erected by the Messenians of Naupaktos to commemorate victories of which the tithe of the booty covered the expense of the erection, a colossal marble Victory on a high triangular pedestal, was executed by Paionios. Even in antiquity there was divergence of opinion as to the event thus commemorated. The taking of Oiniadai by the Messenians of Naupaktos in the 81st Olympiad was a more signal exploit than the participation of Messenian soldiery in the capture of Sphakteria or the harrying of Lakonia after the battle of Pylos. On both occasions plentiful booty was doubtless made. It is probable that the offering was promised to Olympian Zeus in the elation of the successes in Akarnania, but the execution delayed with subsequent reverses until the completion coincided with other victories. The booty coming from different enemies is sufficient reason for the indefiniteness of *δεκάταν ἀπὸ τῶν πολεμίων*. The statue itself reveals astounding progress on the part of its master, without its appearing whether this may be in part due to the influence of Pheidias. The pediment sculptor is recognized in the accommodation of the figure, in position and proportions, for its place on a pedestal over six meters high. The pictorial sculptor betrays himself in the bold conception of a floating figure, and in the use of color and light and shade effects in the drapery, which has some peculiarities in common with that on some of the pediment figures. If the order for the statue was due to the success of the small bronze Victory for the pinnacle of the temple, it is a fair conjecture that the larger statue was an elaboration of the smaller design; the evident copying of Paionios in the acroterion Victories from Delos would thus have a natural explanation. We are again reminded of Ghiberti, introducing in his second door, in freer and larger composition, the subject of his trial-piece.

The Hermes holding the infant Dionysos, found lying before its ancient pedestal in the Heraion, is a work of Praxiteles' youth, the time when the renewed prosperity of Arkadia, brought about by Epaminondas, gave employment to several Attic artists, among whom Kephisodotos, Praxiteles' father, occupied a prominent place.

The coincidence of the subject with that of a group by Kephisodotos mentioned by Pliny, no less than the easily detected imitation of his father and of the Attic sculptor Myron in the forms of the infant and of the head of Hermes respectively, are characteristic of a hand not yet emancipated from the example of its teachers. The detailed treatment of accessories likewise indicates a youthful artist. In the form and pose of the principal figure the perfection of an accomplished master shows the rapid ripening of genius. The spirit and delicacy of the grouping leave nothing to be desired. It is indeed only by comparison with copies of works of Praxiteles' later years that a further advance of the art of figure-sculpture can be conceived. Yet its author made the signal failure of filling a pediment with the representation of the labors of Herakles, thus producing a work on a great scale without unity. In one artist the perfection of one branch of the art is associated with the budding development of another and the manifest decline of a third.

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Professor Gildersleeve's Lecture on the Relations of Literary and Plastic Art.

The concluding lecture of the course was given by PROFESSOR GILDERSLEEVE, on April 9.

Literary art and plastic art may be disparate in their methods and their manifestation, yet the history of both these incorporations of national life shows numerous points of resemblance. The extreme antiquity of literary art—if that is stretched to include spoken art—prevents us from following the earliest growth of Greek poetry as we can follow the putting forth of Greek plastic art, but while we cannot point to Oriental influences as moulding Greek poetry, still, Oriental influences cannot be denied to the history of Greek music which is inseparable from Greek poetry. But the true parallels begin with the development of prose. This the ancient rhetoricians felt perfectly well, and so we find in Cicero, Dionysios of Halikarnassos, Quintilian, elaborate comparisons of the development of oratory and the development of plastic art.

The growth of prose out of poetry presents us with striking analogies to the different stages through which sculpture passed. We have here as there the survival of old technic under new conditions. The translation of an artistic conception from one material to another is reached by slow degrees. The old wooden statues are simply repeated in stone. The legs move on lines parallel with the grain of non-existent wood. The body is kept within the round of a non-existent tree. The low relief of hammered metal is not necessary when one takes soft stone, but it was long before high relief came. The horses keep close to the wall, they are not even pawing to get free. So in literature, in written art, the laws of one department survive in that which grows out of it.

Homer imposes restrictions on the latest of Greek story-tellers, but our information is too scant to enable us to reproduce the restrictions under which Homer wrought. In prose it is otherwise. We are, as it were, present at its birth. It does not come into the world full-grown, floating on sea-foam; it is slowly and painfully evolved. It is called *soluta oratio* in contradistinction to poetry with its fettered gait, but it feels the fetters all the same. It has no ease of motion; it is as if it were galled by the gyves it had put off. Early artistic prose is artificial to a degree. It is absurdly rhythmical, absurdly jingling. Just as blank verse did not get rid of the ghostly authority of rhyme after rhyme was dropped, and a long period passed before it learned the sinuous movement of continuous life, so was it with Greek prose. This is oddly illustrated by Greek inscriptions which often show a peculiar helplessness when prose is imperative. The Greek so nimble with his tongue becomes clumsy with his graver. The flying words lose wings, lose lustre. The inscriptions are apt to fall into tags of verses, wretched verses that would entail punishment on the modern schoolboy, yet verses for all that. So prose when it came into being felt the necessity of mechanical rule to keep itself upright and we are reminded at every turn of the earliest statues—with their wooden parallelisms, their mechanical curls, and the smile that is meant to be blissful.

Of course there is danger in all such comparisons. The epos may be compared with a frieze, the figures of a Pindaric ode with the figures of a metope, the groups in the pediment of a Greek temple remind us of the cast of a Greek drama. Yet the epos is not a frieze, nor an *epinikion* a metope, nor the Greek stage a pediment. Still the studies of literary art and plastic art should not be divorced. Each serves to light up the other. Many passages of Greek poetry get their full light only from plastic art, and, on the other hand, Greek art can never be fully appreciated without a knowledge of the Greek language and literature. It may be possible for genius to get at the heart of Greek life through Greek art alone. To genius no one denies the impossible. But for ordinary mortals Greek art requires the setting of Greek literature, which is after all the most Greek thing we have. So much of plastic art is nothing but translation, often translation by mechanical hands. It has been reserved for our age to make the acquaintance of great originals, to see the Hermes of Praxiteles and the Nike of Paionios. In no age perhaps has Greek poetry been more truly understood, and so no age has been more worthy of this revelation. It would be a pity of pities to dissociate these studies now.

PROCEEDINGS OF SOCIETIES, ETC.

Scientific Association.

May 7.—Fifty-eighth regular meeting. Professor Rowland in the chair. Twenty-five members present.

Papers read:

On Fermentation, by J. R. DUGGAN.

An Account of the Gabbros and associated Hornblendic Rocks in the vicinity of Baltimore, by G. H. WILLIAMS.

On Artificial Circulation through the Vessels of the Animal Body, by L. T. STEVENS.

Preliminary Note on the Energy Spectrum of Incandescent Platinum, by H. F. REID.

Philological Association.

May 2.—Fifty-fifth regular meeting. Professor Gildersleeve in the chair. Twenty members present.

Papers read:

Studies in Dinarchus, by E. G. SIHLER, read by Professor Gildersleeve. (*Abstract on p.* 125).

On K. Brugmann's recent Grammatical Studies, by C. D. MORRIS. (*Abstract on p.* 125).

On Inchoative or *n*-verbs in Gothic and other Germanic Dialects, by A. E. EGGE. (*Abstract on p.* 127).

Historical and Political Science Association.

April 18.—Dr. H. B. Adams in the chair.

The County Institutions of Virginia, by EDWARD INGLE. (*Abstract on p.* 130).

Townships in Rhode Island, by W. E. FOSTER.

Discussion of the Blair Bill, by Messrs. Ramage, Shaw, Wilson, and Dewey.

April 25.—Dr. H. B. Adams in the chair.

Taxation in Kentucky, by ARTHUR YAGER. (*Abstract on p.* 131).

Judicial Procedure among the Boys of McDonogh Institute, by JOHN JOHNSON.

May 2.—Dr. H. B. Adams in the chair.

Nihilism in Russia, by J. I. FAKRBER, of Dorpat.

Theories of Church and State, by J. A. FISHER.

May 8.—Dr. H. B. Adams in the chair.

Congressional Government, by WOODROW WILSON. (*Abstract on p.* 129).

Stephen Hopkins, by W. E. FOSTER. (*Published in Rhode Island Historical Tracts, No.* 19).

May 16.—Dr. H. B. Adams in the chair.

Congressional Government (continued), by WOODROW WILSON. (*Abstract on p.* 129)

Mathematical Society.

April 23.—Dr. Story in the chair. Nine persons present.

Papers read:
A Note on Ruled Surfaces, by W. E. STORY.
On Curvature in *n*-flat space, by G. BISSING.

May 21.—Dr. Story in the chair. Eleven persons present.
On the Equations which Determine the Directions of the Axes of a Quadric Surface, by W. E. STORY. (*Abstract on p.* 123).
A Note on the Divisibility of Numbers, by W. P. DURFEE.
On the Number of Substitutions of *n* letters which leave *k* of them unaltered, by W. P. DURFEE.

Metaphysical Club.

April 22.—Thirty-eighth regular meeting. Dr. G. S. Hall in the chair. Eleven members present.

Papers read:
Mind as a Social Factor, by LESTER F. WARD, of Washington.
On the Syllogism, by J. R. HARRIS. (*Abstract on p.* 131).

May 13.—Thirty-ninth regular meeting. Mr. C. S. Peirce in the chair. Twenty-one members present.

Papers read:
The Logic of Religion, by C. S. PEIRCE.
The Writings of the Insane, by H. STEINER.

Archæological Society.

May 9.—Fourth general meeting. Professor Gildersleeve in the chair. Fifteen members present.

Papers read:
On the History of Mosaic Painting since the Christian Era, by A. L. FROTHINGHAM, JR. (*Abstract on p.* 128).
On a Collection of Electrotype Reproductions of Ancient Coins, by A. EMERSON.

Reports:
On the proposed new regulations of the Archæological Institute of America, by A. EMERSON.
On an interesting Greek Christian Inscription of Rome discovered by O. Marucchi, by A. L. FROTHINGHAM, JR.

Baltimore Naturalists' Field Club.

April 30.—Dr. G. H. Williams in the chair. Eleven members present.

MR. LUGGER reported the discovery of Hornia minutipennis.
This beetle belongs to the large family of Meloidæ, and is parasitic in the nests of the common mason bee. The insect was described and its life history given. Its development is very peculiar, passing through the following stages; egg, first larval stage or triungulin, second larval stage, comprising the carabæid and scarabæid forms, third larval stage, semi-pupa, followed again by a form looking like the third larval stage, true pupa and imago. Mr. Lugger also gave an account of the deve opment of Cænia dimidiata Fab., which he has succeeded in raising to maturity from the larva. The larva looks like the cast-off skin of the common oniscus. The transformation from the larva to the pupa takes place within the larval skin, the latter splitting open along the sides. The pupa is at first snow-white, as is also the imago, the latter soon changes to a sky blue and then to a black with orange colored elytra.

DR. BARTON of the botanical section made a report of the field work during the past month, and stated that several interesting additions had been made to the collection.

DR. WILLIAMS of the geological section made a communication on "The so-called Quartz-porphyry at Hollins station, N. C. R. R., north of Baltimore." (*See p.* 132 *of this Circular*).

May 25.—Dr. G. H. Williams in the chair. Ten members present.

MR. LUGGER gave an account of a strange hymenopterous parasite infesting the larva of Tiphia.
The Tiphia lays its eggs in the so-called white grub, or the larva of Lachnosterna fusca; the larva of the Tiphia when nearly mature eats the white grub and then spins for itself a beautiful silken cocoon. This larva in turn is often infested by the larva of the Rhipiphorus pectinatus or R. limbatus, the eggs of which have become fastened to the Tiphia, and in this way reach the Tiphia cocoon—as stated Mr. Lugger has also found in the same cocoons small hymenopterous parasites. The order of events in this case appears to be that the larva of a large coleopterous insect is destroyed by a hymenopterous larva, this in turn by a coleopterous larva, and this again by a hymenopterous larva.

DR STERNBERG made an address on micrococci, with especial reference to the micrococcus of pneumonia, which has lately been described.

MR. DONALDSON showed two specimens of Liparis liliifolia found at Texas, N. C. R. R., Md., which possessed the keeled leaves characteristic of L. læsellia. He also mentioned a fertile plant of Podophyllum peltatum with only one leaf, and a sterile specimen with the stem continued into a leaf-like structure.

MEETINGS OF ART CIRCLES.

Under the auspices of the University Archæological Society, DR. A. L. FROTHINGHAM, JR., has organized several circles for the study of various phases of art, illustrated by photographs and engravings. The meetings have been held in the rooms of the Peabody Institute and the following subjects have been taken up.

First. March 1, on Romanesque Architecture. (16 present).

Before the Romanesque period (XI and XII centuries) there had flourished since the Christian era four styles of Architecture: the Roman, the Eastern (especially Syrian), the Byzantine, and the Lombard: and from a combination of various elements existing in these styles Romanesque Architecture was formed. Its general characteristics are grandeur, simplicity, and power, while during the two centuries when it held sway not only did each country have a distinct form of the style, as France, Germany, Italy, England, and Spain, but every one of these still ununited countries included schools possessing traditions and methods of their own, and developing independently of each other. Some reached a higher scientific development than others, and obtained better results in their endeavors to solve the main architectural problems of the age—the problems connected with the arch and the vault. So that, while by some schools (especially those of Auvergne, Poitou and Perigord in France) completely vaulted churches were built as early as the middle of the XI century, most of the schools lagged far behind and used wooden roofs until the middle of the XII century.

Second. March 8, on Gothic Architecture. (12 present).

A sharp distinction must be drawn between the Transition-style, which formed the link between the Romanesque and the Gothic, and the Pointed style which, although using the pointed arch, had none of the constructional peculiarities of the Gothic. Amidst many conflicting claims it seems certain that Gothic architecture arose (c. 1200) in Northern France and more particularly in the province of the Ile-de-France, where we also find (c. 1150) the style of transition Nowhere are the attributes of true Gothic so well exemplified as in the great cathedrals of Rheims, Amiens, Chartres, and Bourges. From thence the Gothic style spread to other countries: although France, England, Germany, Italy, and Spain had different forms, these were mainly *national*, and there did not exist nearly so many distinct schools as in the Romanesque period. In the XIV century Gothic lost its originality and artistic feeling; it lived on the past; and in the XV century it was overrun with purposeless ornamentation and its forms became perverted and debased, losing the lightness, symmetry, and beauty which characterized its early period.

Third. March 22, on Italian Sculpture during the XIII-XV Centuries. (10 present).

The revival of Italian Sculpture is all the more remarkable that previous to Niccola Pisano it was sunk so low as to seem incapable of renewed life. Niccola's style was not adopted by the school he founded; his massive, powerful figures, full of a quiet majesty, were exchanged for slender, artificial forms, and while the influence of the antique may be traced in him, it is entirely wanting in his successors.

Giovanni his son came under the influence of foreign Gothic art, and the same may be said of the rest of the school. Andrea Pisano, however, and the great unknown sculptors of the Orvieto Cathedral seem to return to an earlier and simpler style, related to Giottesque painting.

The second great phase, beginning with the first years of the XV century shows us the great names of Jacopo della Quercia, Lorenzo Ghiberti, and Donatello. The pictorial style introduced by Ghiberti was fortunately counteracted by the more powerful genius of Donatello aided by the correct artistic taste of the time. It was Donatello who formed most of the sculptors who then acquired renown; but none reached to his height. The cause of his influence was not only that he conceived most completely the naturalistic type of his time, but that he commenced the renaissance of the classical ideal. On the other hand, Luca della Robbia was essentially a religious sculptor and founded an extensive Robbia school. He revived the earlier religious art with greater sentiment and beauty of form, and took, in sculpture, the position corresponding to that of Fra Angelico in painting.

Fourth. March 29, on Italian Painting during the XIV Century. (13 present).

The XIII century was in Italy the period of the greatest degradation in painting, when exaggeration of expression and distortion of form reached their climax. Giunta of Pisa, Guido of Siena, the Berlinghieri of Lucca and Margharitone of Arezzo do not rise much above the general standard. The revival in Tuscany,—headed in Florence by Cimabue and in Siena by Duccio,—was a regenerated form of Byzantine art: but a new departure, more humanistic and naturalistic in every way, and which spread rapidly in all directions, was taken by Giotto, to whom Simone Memmi corresponds in the Siennese school. During the XIV century these two Tuscan schools reigned supreme, and the few painters who flourish in other provinces acknowledge the rule of their style. Of the rivals, the Florentine adopts a relatively intellectual, and the Siennese a sentimental ideal. After Taddeo Gaddi, Giotto's great pupil, the Giottesque style became rapidly debased, and the Florentine School does not produce any great painter besides Andrea Orcagna, who was a universal master *sui generis*. In Siena the most important successors of Simone Memmi were the two Lorenzetti: there, also, at the close of the century a retrogressive movement takes place.

Fifth. April 5, on Italian Painting during the XV Century. (15 present).

The XV century witnesses a great revolution in the Florentine school and its dependencies; while the school of Siena continues to represent the ideal of the XIV. This revolution in Art was caused by human nature being taken as its ideal and its model: hence the uniformity of the preceding period was replaced by distinct and new species developing side by side and which we may call the religious, the naturalistic, the realistic, and the classical.

The ideal and religious style not according with the spirit of the age lost much of its life; but it was reborn in Fra Angelico whose paintings seem inspired and in Fra Filippo Lippi who is inferior only to him; while at the close of the century the school is represented by such great painters as Perugino and Pinturicchio.

Masaccio was the prophet of the naturalistic and psychological school which was completed in Sandro Botticelli, Domenico Ghirlandaio and Filippino Lippi who develop portraiture in religious subjects to its limits. Another form is exemplified by Giovanni Bellini in whom the great power of color appears.

The realistic and scientific school headed by Andrea del Castagno and Piero della Francesca studied the human body with a realism repugnant to true art. The Pollajuoli carried this to its extreme limits: Andrea del Verocchio somewhat refined it. The classical renaissance was not so striking in painting as in sculpture: it however inspired many works of Sandro Botticelli, Andrea Mantegna, and Luca Signorelli. Mantegna and Signorelli were the giants of the century, men of comprehensive genius whose influence was lasting: the latter was hardly surpassed by Michel Angelo in mastery over the human figure.

Sixth. May 3, on Ivory Carving from the IV to the XV century. (6 present).

Art history is often best illustrated by its smallest productions: this is emphatically the case with carvings in ivory; not being of a precious material they have been preserved in great numbers and in uninterrupted sequence. The consular diptychs of the IV-VI centuries form an important series: they generally figured the consul presiding over the games. Many articles of ecclesiastical use were carved in ivory, such as church diptychs, pyxes, holy-water vessels, vases, caskets, book covers, and later *flabella*, *aspersoria*, devotional tablets, triptychs, &c. All these works were carved with the subjects of Christian art.

After the classical and Byzantine period a new style came up with the Carlovingian revival: this was succeeded by a degradation, with some improvement during the Romanesque period. At this time this branch of art was reaching great perfection in the Eastern Empire. When the Gothic style arose there was a great renaissance in ivory carving which became very popular: in France especially it was impressed with all the delicacy and refinement of Gothic sculpture, and many prominent artists devoted themselves to this branch. In Italy, Venice became famous for this specialty and exported carved ivories largely to other countries, while Germany, Spain, and England all possessed national schools.

THE ARCHÆOLOGICAL INSTITUTE OF AMERICA founded five years ago for the promotion of archæological research and discovery on classical and American soil, by action of its Council in Boston May 17, 1884, urged the formation of affiliated societies in other cities. These societies, besides sharing in the general advantages of the Institute, may, by electing members into the General Council, influence the work undertaken by the Institute, and create local interests by meetings, publications, etc.

The University Archæological Society appointed Drs. Emerson and Frothingham a committee to forward the formation of a Baltimore Society by the addition of other members. The old and new members of the Institute were invited to meet on June 5th, at 8 p. m., in President Gilman's office for the formal organization of the Society. Mr. John W. McCoy, whose interest in art and archæology is well-known, was chosen President, Dr. Emerson and Dr. Frothingham were named respectively recording and corresponding secretaries. The Baltimore Society at present numbers twenty-three members, as follows: Charles J. Bonaparte, George W. Brown, Arthur M. Elliott, Alfred Emerson, Arthur L. Frothingham, Jr., Miss Mary Garrett, Robert Garrett, T. Harrison Garrett, Basil L. Gildersleeve, Daniel C. Gilman, Edward M. Greenway, Jr., Joshua G. Harvey, Reverdy Johnson, Miss E. T. King, John W. McCoy, N. H. Morison, Charles D. Morris, Edmund Law Rogers, William W. Spence, S. Teackle Wallis, Harry Walters, Minton Warren, Miles White, Jr.